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Study of Lead Pollution

in

Granite City, Madison and Venice, Illinois

April 1983

Illinois Environmental Protection Agency
2200 Churchill Road
Springfield, Illinois 62706

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I) INTRODUCTION

During the last quarter of 1981, the Illinois Environmental Protection Agency's (IEPA's) air pollution monitor at 15th and Madison Streets in Granite City registered an unusually high average of lead. The sudden increase in airborne lead was unexpected because, up until then, the lead levels had been declining at that location. A preliminary investigation based on an analysis of meteorological data indicated that the lead came from the direction of the nearby lead smelter (Taracorp Industries) and a neighboring recycling operation (St. Louis Lead Recyclers). But a check with company officials and other area businesses did not reveal any obvious cause, such as an air pollution control equipment malfunction or a big jump in production. The average lead concentration at this monitoring site has since dropped, but at another monitoring site, it is still higher than the national health standard.

Up until the 1981-82 winter, the Agency thought that equipment and operating improvements at the smelter and the declining amount of lead in car exhausts would combine to bring airborne lead down to an acceptable level. But the jump in the 1981 fourth quarter average indicated that more may need to be done.

The Agency was concerned that the potential existed for another sudden rise in airborne lead and that unidentified sources of lead emissions might prevent the air quality of the area from improving. In mid-1982, the Agency began a more intensive investigation into the sources of lead in the vicinity of the monitor at 15th and Madison. To help pinpoint all the lead sources, another monitor was placed in the area. The Agency also began taking dust samples from open areas, streets and parking lots to get a more complete picture of where the lead was coming from and to assess the extent of contamination.

As part of the study the Agency also tried to determine if lead ingestion by people living in the study area is above recommended limits. Garden vegetable samples were collected, water testing records were reviewed, and soil samples were analyzed.

Another part of the study, conducted in cooperation with the Illinois Department of Public Health (IDPH), focused on the potential health effects of excessive lead levels in the environment.

This study report has been prepared by the IEPA. Participating in the data collection phase of this study with IEPA were the Illinois Department of Public Health, the United States Environmental Protection Agency, the United States Food and Drug Administration and the City of Granite City.

The hazard assessment portion of the study and the health-related recommendations contained in this report were developed by the IEPA in close cooperation with the Environmental Toxicology and the Lead Poisoning Control programs of the Illinois Department of Public Health. Their input and critical review of Section X of this report were particularly helpful.

II) SUMMARY, FINDINGS AND RECOMMENDATIONS

Although significant contamination of the environment exists in the vicinity of the secondary lead smelter, the preliminary assessment of the IEPA and the IDPH is that a major near-term risk to public health is unlikely to exist provided that ambient air quality levels do not exceed the National Ambient Air Quality Standard and that routine personal health and hygiene measures are followed. However, the high levels of lead found in the soil on and near the smelter site are cause for continued concern. Because uncertainty remains regarding the long-term health implications of these high soil-lead concentrations, prudence dictates that dust control measures be implemented immediately. Further ground water and blood testing planned for the area will indicate what additional pollution control measures are necessary to reduce health hazards.

A) Blood Samples

1. The Illinois Department of Public Health (IDPH) took blood samples from 97 individuals in 43 households within two miles of the lead smelter in Granite City during November and December 1982.

2. The amount of lead and FEP (a lead-related enzyme) found in the blood samples falls in the range considered to be acceptable by health practitioners. No cases of lead blood poisoning were found, nor were there any excessively high blood lead levels. Blood-lead tests are an indicator for lead exposure during the previous 90 days only. FEP tests, however, are indicative of longer exposures. The IDPH considers a blood-lead level of 30 micrograms per deciliter (ug/dl) or greater, in combination with an FEP level of 50 ug/dl or greater, to be dangerously high. For children six years old or less, the blood-lead samples averaged 10 ug/dl and the FEP levels averaged 17 ug/dl.

3. Forty-six children age six and under were tested. This is not as many as the testing program set out to obtain and not enough to draw broad conclusions about the rest of the children living in the area. The results of the 46 children's blood tests, however, provided no evidence that there are lead-related health problems present in the area. If the blood-lead and FEP levels of children in the survey remained the same in the years to come, these children would not be expected to develop lead-related health problems.

4. Because uncertainty remains in the conclusions drawn from the blood sampling data, the IDPH will continue to offer free blood tests to residents at its Granite City office (4700 Nameoki Road, phone 618/931-4545).

B) Soil Samples

1. Lead levels in the soil in some residential areas are very high. Near the lead smelter two surface soil samples exceeded 5000 parts-per-million of lead.

2. Fifty surface soil samples gathered in Granite City, Madison and Venice indicate that soil out to a distance of one and a half miles from the lead smelter has higher lead content than the levels of 50-100 parts per million found in other communities.

3. Generally, soil within one-half mile of the smelter can be expected to contain 1000 parts per million of lead.

4. Many other studies that have found high lead concentrations in soil have also found high blood-lead levels in people living in the same area. That relationship was not found in this study.

5. The health and hygiene practices listed below are generally recommended for anyone living in an urbanized/industrialized area, but they are particularly important for people living within about one-half mile of the smelter because of the high lead levels in the soil.

   A. Small children, generally six years old or less, should not be allowed to play in dirt. However, normal sport or play activities on dirt areas by children and adults do not need to be restricted.

   B. No one in the area, especially children, should put dirt, dirty hands or dirty objects in their mouths.

   C. Grass or other ground cover should be planted in residential yards where dirt is exposed.

   D. Children should not eat outdoors if they are likely to get soil on food or on their hands while eating.

   E. Everyone should wash their hands and faces thoroughly before eating.

C. Water Samples

1. Four groundwater monitoring wells were drilled by Taracorp at the Agency's request in November, 1982.

2. The initial groundwater samples have shown no significant lead pollution. However, not enough samples from different locations have been taken to draw conclusions. Sampling is continuing.

3. Granite City, Madison and Venice do not use groundwater as their source of drinking water. Drinking water test results fall well below the State's standard of 50 ug/l for lead.

4. A soil sample taken at the 14-15 foot level while drilling one well revealed an unusually high concentration of lead (2700 parts per million). Samples taken in the same boring at 5, 10, 20, 25 and 30 feet showed lead concentrations no higher than 50 ppm. Further sampling will have to be done to determine the cause of the high lead level at the 15-foot depth which was just above the water table.

5. Surface water runoff goes into the city's storm sewer system and subsequently to the waste water treatment plant. The effluent from the treatment plant meets lead water quality standards.

D. <u>Garden Samples</u>

1. In the fall of 1982 vegetables were taken from seven gardens in Granite City and analyzed in a United States Food and Drug Administration laboratory for lead. Soil samples were taken from each garden to see if a correlation existed between lead in the soil and lead in vegetables.

2. The garden vegetables analyzed included: peppers, tomatoes, banana peppers, cauliflower, eggplant, okra, carrots, tomatoes, cabbage, cucumbers, peas, squash, and beets.

3. Health experts estimate that on the average children 0-2 years old take in approximately 100 ug of lead each day in the food they eat. By the time children reach 8 1/2 years old they are taking in approximately 210 ug each day. The vegetables analyzed in this study showed higher lead levels where soil-lead concentrations were high. However, the levels were still low relative to the normal dietary intakes noted above.

4. Nevertheless, because of the high lead content of the soil, there are several recommendations that people with gardens within one-half mile of the smelter should follow:

   A. All vegetables from home gardens should be washed thoroughly before being eaten.

B. Garden soil should be tested periodically for phosphorous and pH levels. A neutral pH helps inhibit plant uptake of lead, as does an adequate amount of phosphorous.

C. The Madison County Cooperative Extension Service Office (618/656-8400) can advise people on how to collect a proper sample and where to send it for analysis. It will cost approximately $4 to have the phosphorous and pH tested. Additionally, the extension adviser will interpret the test results for gardeners and instruct them on how much lime or fertilizer needs to be added.

E) Air Samples

1. Lead monitoring began in Granite City and the rest of the State in 1978. Since then, the lead monitoring site at 15th and Madison Streets in Granite City has recorded 14 violations of the federal lead health standard (1.5 micrograms of lead per cubic meter of air as a quarterly arithmetic average).

2. The highest quarterly average at 15th and Madison was 7.3 ug/m^3, measured in the last quarter of 1981. Prior to that, the highest average was 4.4. Since 1981 the highest quarterly average has been 1.9 ug/m^3.

3. Wind speed and direction studies for those days when the highest ambient air concentrations of lead were measured show that the lead was coming from the direction of the Taracorp lead smelter.

F) Lead Source Evaluation

1. The Taracorp facility, which was purchased from N.L. Industries in 1979, is a secondary lead smelter located in Granite City. It takes lead from discarded batteries and other lead bearing wastes and reprocesses it into products such as sheet lead, solder, shot gun pellets, lead wool and lead ingots. The major process emission sources at Taracorp include a blast furnace, a rotary furnace, lead melting kettles and a battery breaker.

2. The smelter property contains a three-acre storage pile of broken batteries, blast furnace slag and other lead waste products.

3. Surface soil samples taken at the rear gate of the Taracorp smelter contained 140,000 to 300,000 parts per million (or 14 to 30 percent) lead.

4. On C ɔber 1, 1982, Taracorp Industrie. filed bankruptcy under Chapter 11 of the Federal bankruptcy laws and is seeking reorganization.

5. St. Louis Lead Recyclers, which began operation in 1980, is adjacent to Taracorp. Since 1982 it has been reclaiming lead from Taracorp's waste pile.

6. The IEPA's preliminary evaluation of these two operations indicates that lead emissions should be reduced. Consistent with this conclusion, the Agency has taken the following related actions:

   A. Denied a recent permit renewal application submitted by Taracorp for its blast furnace and associated equipment. Taracorp has appealed this denial to the Illinois Pollution Control Board.

   B. Coordinated with USEPA to obtain a formal engineering review of Taracorp and St. Louis Lead Recyclers and make recommendations regarding potential control measures. This review has been completed and a report is currently being prepared by USEPA.

   C. Requested the Illinois Attorney General to review the number of environmental law violations found at these sites and to obtain legally binding agreements from the companies regarding the implementation of control measures.

7. Although additional analytical work is underway to further delineate the sources of lead emissions, the IEPA believes that certain dust control measures should be implemented immediately to minimize lead emissions. These measures include: on-site traffic control; the paving or treating of roadways, parking lots and other traffic areas; regular cleaning of paved areas; covering open dirt areas with vegetation; and, fencing to reduce wind erosion. These and other measures, as they are developed, will be incorporated in the Attorney General's enforcement activities.

III) STATE IMPLEMENTATION PLAN FOR AIR POLLUTION CONTROL

The United States Environmental Protection Agency (USEPA) officially listed lead (Pb) as an air pollutant on March 31, 1976 and proposed regulations for a National Ambient Air Quality Standard (NAAQS) on December 14, 1977. After a lengthy comment period, final designation of a NAAQS of 1.5 micrograms of lead per cubic meter of air (ug Pb/m^3) averaged over a calendar quarter was promulgated on October 5, 1978. On the same date, regulations for states to follow in developing a lead pollution control plan were also issued.

The IEPA completed the Illinois State Implementation Plan (SIP) for Lead (Vol. 9 of the Illinois SIP) in February 1981. Sixteen locations in the State were closely examined, but none were judged to present potential health problems, with the exception of the Granite City-Madison-Venice area.

IEPA formally submitted the Lead SIP to USEPA on July 21, 1981 and requested that two congressional townships (R10W, T3N; and R9W, T3N which encompass the civil townships of Venice, Nameoki and Granite City) in Madison County be designated nonattainment. In the March 22, 1982 Federal Register (Vol 47, No. 55) a final rulemaking was published by USEPA stating that the State had adequately demonstrated attainment and maintenance of the NAAQS for lead in all areas of the state except Granite City-Madison-Venice. The State is required to develop a control plan for the area that will ensure attainment and maintenance of the NAAQS. The control program measures implemented subsequent to completion of the Granite City-Madison-Venice lead study will form the basis for revision of the SIP.

The problem in the area is principally related to past and current emissions associated with a secondary lead smelter. This facility is presently owned by Taracorp Industries; however, prior to the fall of 1979, the facility was owned and operated by N.L. Industries. The analyses presented in this report and SIP Volume 9 indicate that current emissions from the facility still significantly contribute to air quality levels exceeding the national lead standard and that residual lead build-up in the soil surrounding the plant also contributes significantly to the ambient lead problem.

IV) HISTORY OF AFFECTED AREA

The area with significant lead environmental contamination includes southwestern Granite City, northern Madison and northern Venice.

Data on the highest ambient air lead concentrations and the most significant lead emissions has focused attention on a section of land containing two major facilities: Taracorp Industries, a secondary lead smelter; and St. Louis Lead Recyclers, a lead reclamation facility.

Taracorp purchased the existing secondary lead smelter from N.L. Industries (formerly National Lead Company) in August of 1979. N.L. Industries took over the facility from the United Lead Company in 1928. The United Lead Company had acquired the facility from the Hoyt Metal Company in 1903. Most of the smelter is believed to be of original construction.

St. Louis Lead Recyclers came into existence in 1980. The company's original purpose was to reclaim lead from batteries. However, it soon entered an agreement with Taracorp to begin reclaiming lead from Taracorp's waste pile. Reclamation operations on the waste pile began in 1982.

Many other industries are located in the general area but none of them appear to contribute substantially to the lead problem.

V) PROCESS DESCRIPTION OF TARACORP AND ST. LOUIS LEAD RECYCLERS

A) Taracorp

Taracorp is a secondary lead smelter which produces numerous lead products. These products include sheet lead, solder, shot gun lead pellets, lead wool, powdered lead and secondary lead ingots. The facility has a blast furnace (cupola), a rotary furnace, a number of lead melting kettles, a battery breaker operation, a natural gas fired boiler, and air pollution control equipment including several baghouses, cyclones, and an afterburner. A schematic of the Taracorp operation is provided in Figure V-1.

B) St. Louis Lead Recyclers

St Louis Lead Recyclers reclaims various materials from the Taracorp waste pile. The process consists of the following steps:

1) Material from the waste pile is placed in a dump truck with a frontend loader. The truck is then weighed.

2) The material is then screened and hand sorted. Slag, matte, and trash are loaded back in the truck and reweighed. This weight is subtracted from the weight of material originally removed from the pile. The slag, matte, and trash have been returned to the pile in the past. However, the future disposition of this material is in question.

3) The remainder of the sorted material (battery cases, scrap, etc.) is transported to the recycling process.

4) The material for recycling is first crushed, shredded, and sprayed with a surfactant.

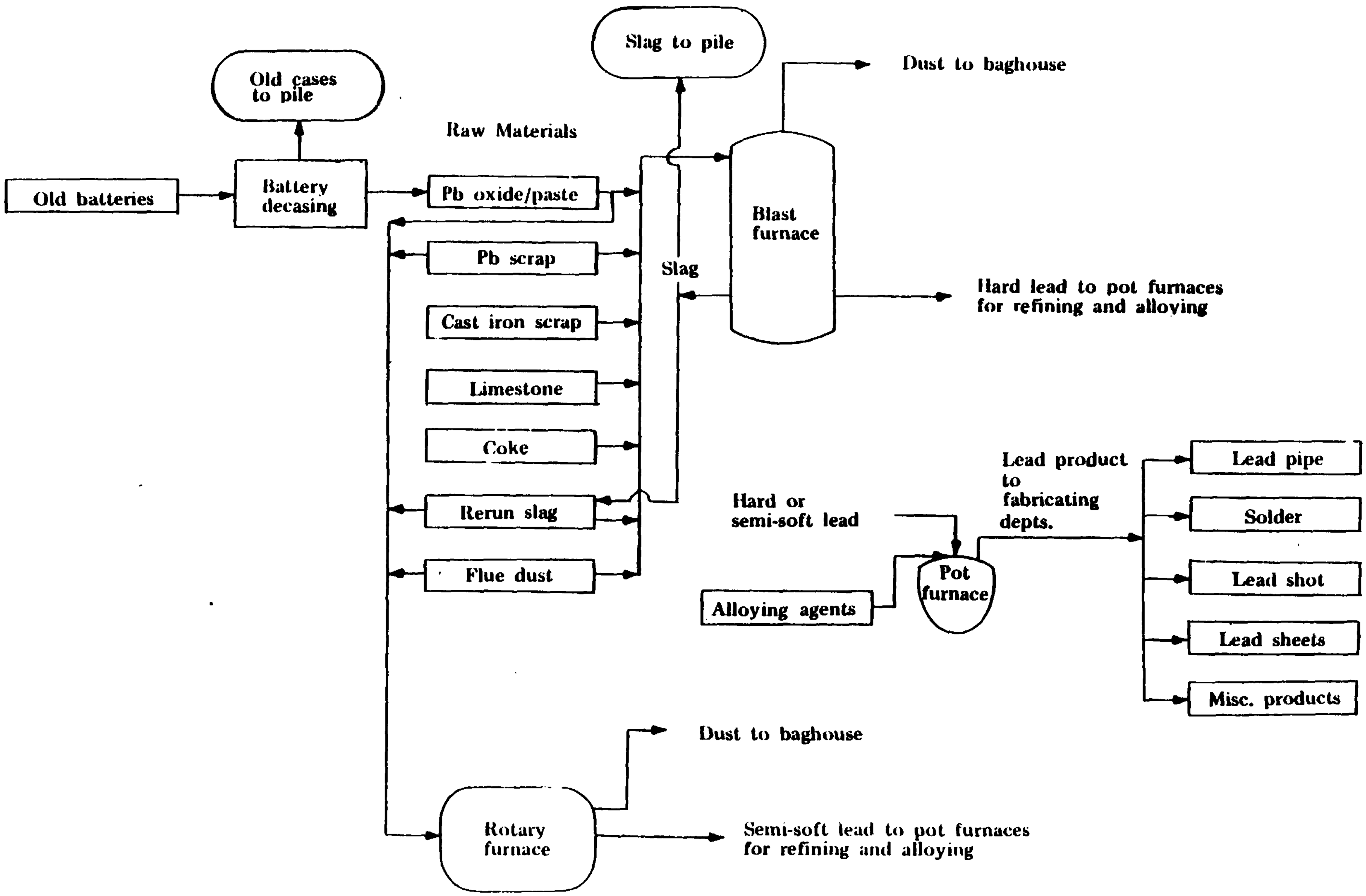
5) A wet separation process separates the lead oxide and elemental lead from the plastic and hard rubber (from battery cases).

6) An additional process separates the lead oxide from elemental lead. These materials are sold back to Taracorp, following aggregation in a quick-melt furnace.

7) The plastic and hard rubber are separated by floatation and washed. The plastic is sold to a plastic recycler. The hard rubber is presently being stockpiled while a market for it is being sought.

8) Water used in the process is clarified and recirculated.

Figure V - 1: Process Flow Diagram for Taracorp Secondary Lead Smelter



VI) AIR POLLUTION ASSESSMENT

A) Air Quality Monitoring

The IEPA's Division of Air Pollution Control has been monitoring ambient levels of lead on a statewide basis since mid-1978. Prior to 1978, lead air quality data were collected only within Cook County by local agencies. Table VI-1 lists the quarterly ambient lead averages (based on individual 24-hour samples taken every six days) for monitor locations (see Figure VI-1) in Granite City which have exceeded the Federal lead standard of 1.5 micrograms per cubic meter (ug/m^3) as a quarterly arithmetic average. The highest recorded quarterly average in Illinois was 7.3 ug/m^3, monitored at the 15th and Madison Street monitoring site. This same site has recorded 14 violations of the lead standard during the period 1978 through 1982. This is the most violations recorded at any monitoring site in Illinois. The ambient lead data is presented graphically in Figure VI-2.

Table VI-1
Ambient Lead Monitoring Data Summary
(1978 - 1982)
Quarterly Averages (ug/m^3)

Yr/Qrt	15th & Madison	20th & Adams	Roosevelt & Rock Rd.	1733 Cleveland
1978 - 1	-	-	-	-
2	3.1	0.6	0.7	-
3	1.7	4.4	1.3	-
4	4.4	4.0	1.7	-
1979 - 1	2.6	1.0	1.3	-
2	3.2	0.9	1.2	-
3	2.0	1.1	1.3	-
4	3.0	2.6	1.2	-
1980 - 1	3.0	0.5	0.6	-
2	1.2	0.6	0.5	-
3	1.0	0.5	0.7	-
4	1.9	0.6	1.4	-
1981 - 1	2.1	0.5	0.5	-
2	1.0	1.6	0.9	-
3	1.8	0.5	1.1	-
4	7.3	0.5	0.9	-
1982 - 1	1.9	0.8	1.1	-
2	1.6	0.9	1.5	-
3	1.1	0.5	0.6	-
4	0.9	0.6	1.8	1.5

Figure VI - 1: Location of Lead Air Quality Monitors

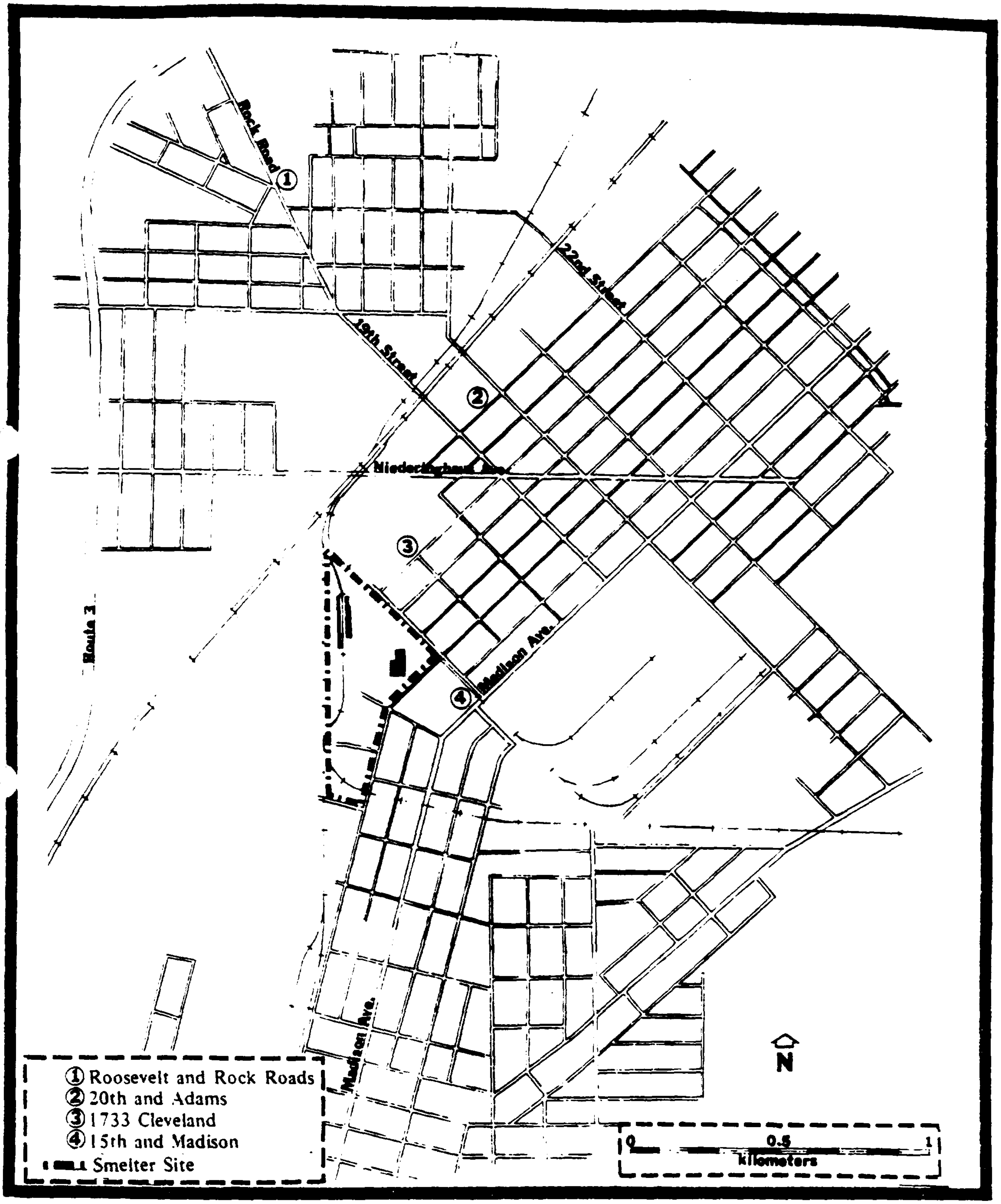
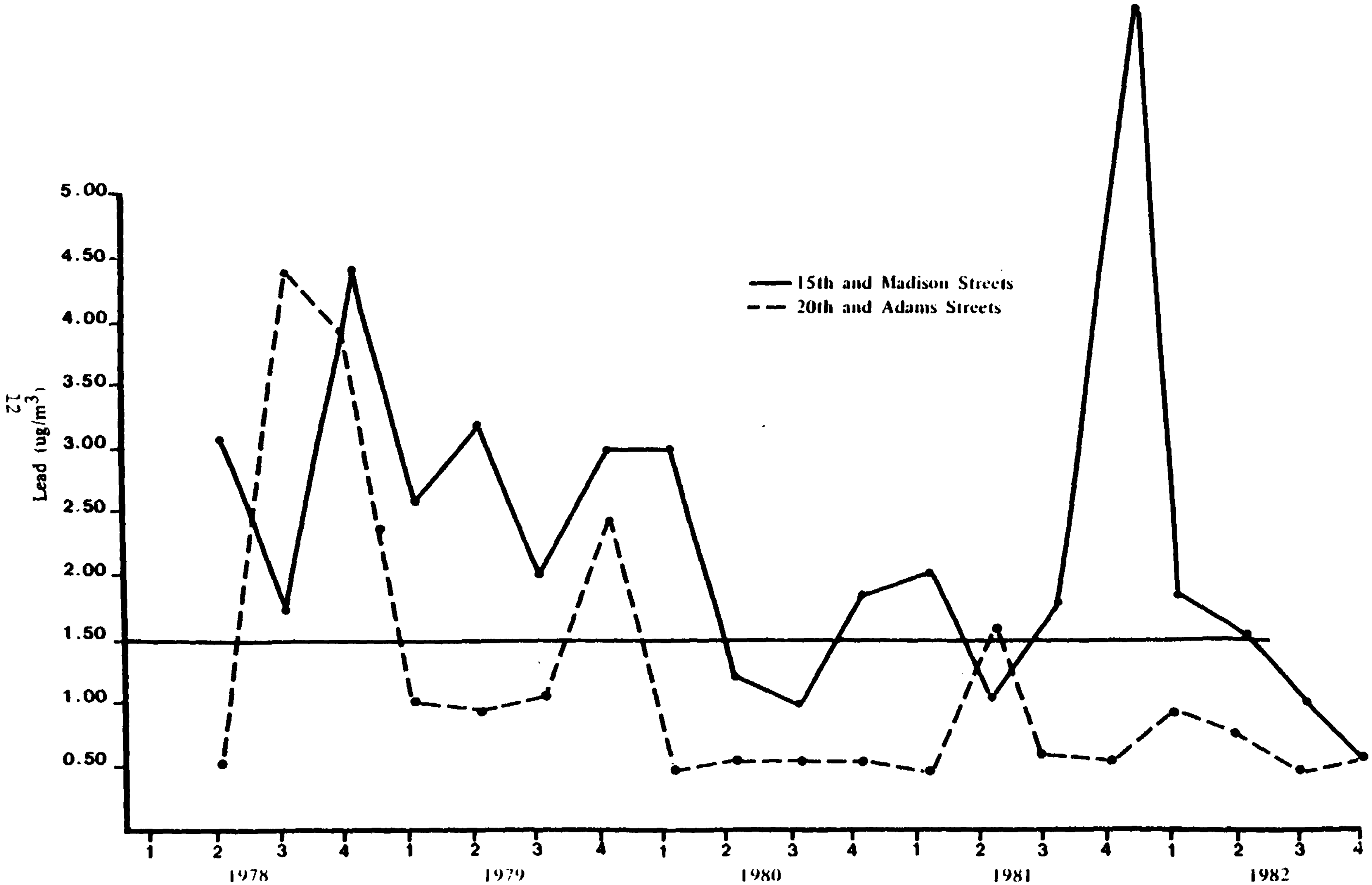


Figure VI - 2: Quarterly Ambient Air Lead Levels for Selected Granite City Monitors



B) <u>Monitoring/Meteorological Analysis</u>

To help pinpoint the emission sources contributing to high lead levels, composite wind frequency distributions were generated for each of three monitoring sites (15th and Madison, 20th and Adams, and Roosevelt and Rock Road) for days in 1981 and 1982 with lead concentrations greater than or equal to 1.0 ug/m^3.

The wind data used in the analysis was taken from the IEPA monitoring sites in East St. Louis and Edwardsville and the National Weather Service's station at Lambert Field in St. Louis.

Figure VI-3 is a graphical depiction of the composite wind frequency distributions (pollution roses) for 1981. Figure VI-4 depicts the wind directions at each site on high ambient lead concentation days in 1981. This cross-hatched area is indicative of the location of the most probable lead emission source contributing to the high lead concentrations.

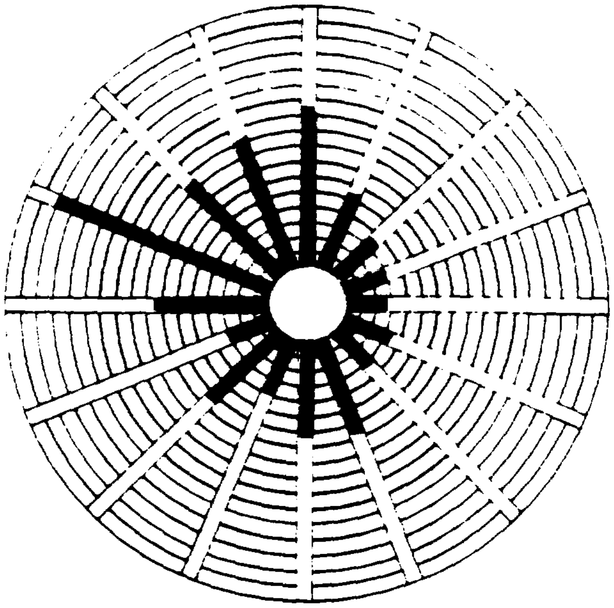
The same type of analysis was performed for 1982 wind data. Figure VI-5 depicts the pollution roses for the four monitors exhibiting high lead levels in 1982. Figure VI-6 depicts the range of the peak directions at each site on high ambient lead concentration days in 1982. Again, the cross-hatched area indicates the location of the most probable source contributing to the high lead concentrations. Taracorp Industries and St. Louis Lead Recyclers are located within the cross-hatched area. Less emphasis should be placed on the new monitor at 1733 Cleveland since it it was only recently installed and, thus, operated for less than one-fourth of the entire year.

C) <u>Deposition Patterns</u>

Soil samples were taken throughout the area. Samples used to determine deposition patterns were taken from vegetated areas in which there was no evidence of recent disturbance (these samples were termed "Soil A"). In addition to determining the concentration of lead, several other metals were examined. Arsenic, antimony and tin were evaluated because they are generally present in significant quantities in lead smelter emissions.

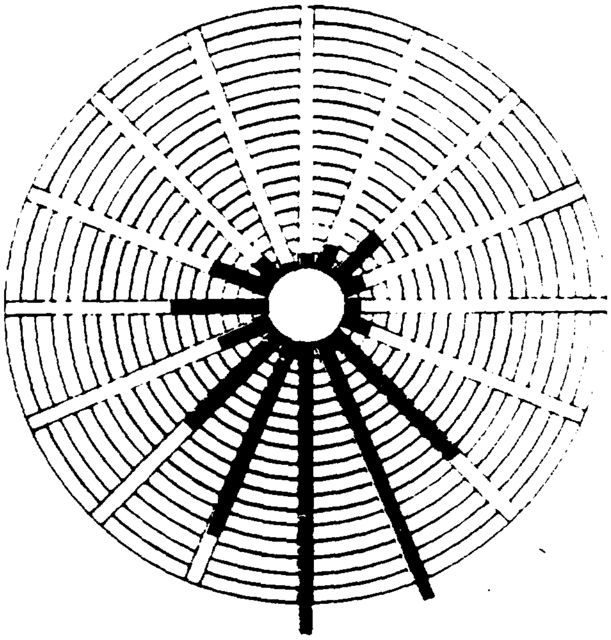
Figure VI-7 presents the results for lead. Because of the relatively small sample size, these isopleths (i.e., lines connecting points of equal concentration) should be considered only rough approximations of equal soil-lead concentration areas.

Figure VI - 3: Wind Frequency Distribution on High Lead Days in Granite City During 1981

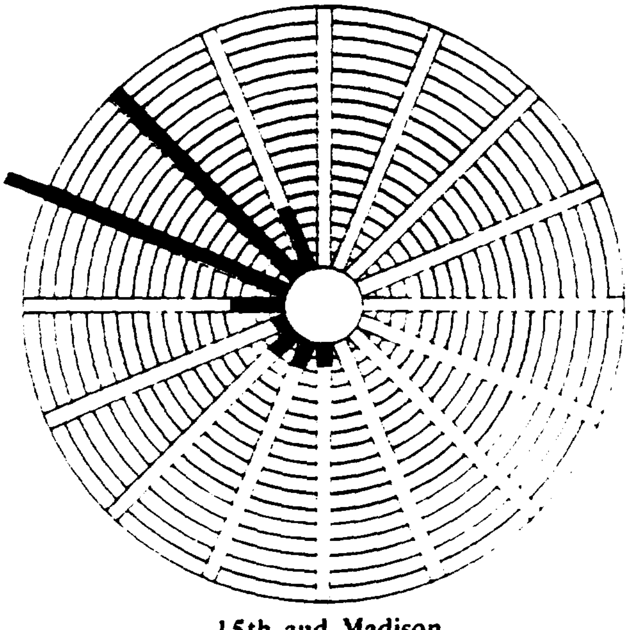


15th and Madison
(all days)

Each line equals 1%

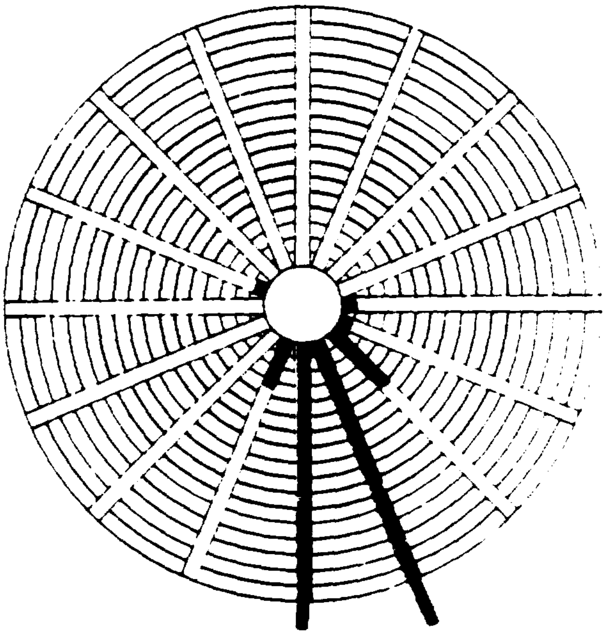


20th and Adams



15th and Madison
(above 10 ug/m3)

Each line equals 2%



Roosevelt and Rock Road

Figure VI - 4: Overlap of Lead Pollution Roses for 1981

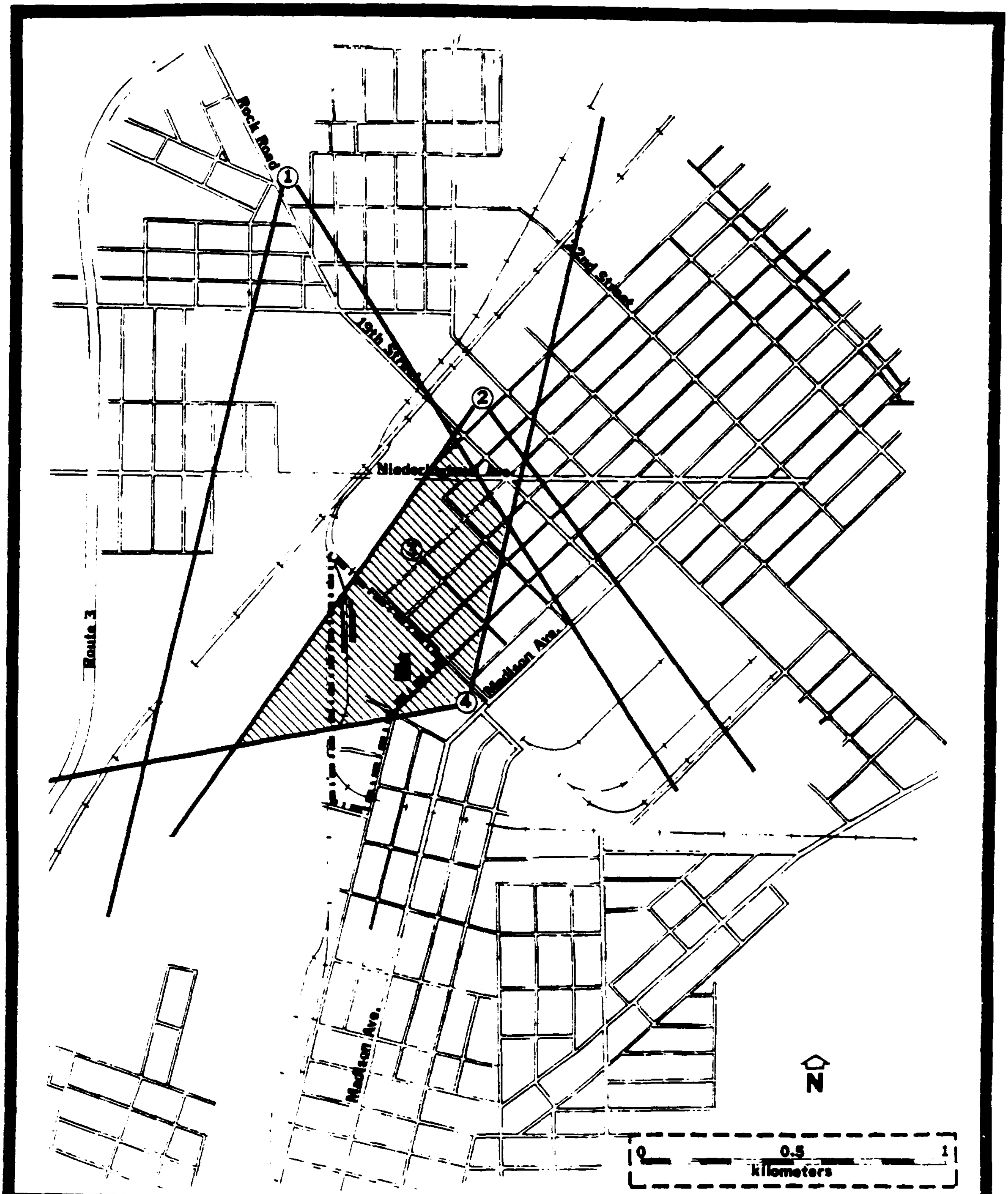
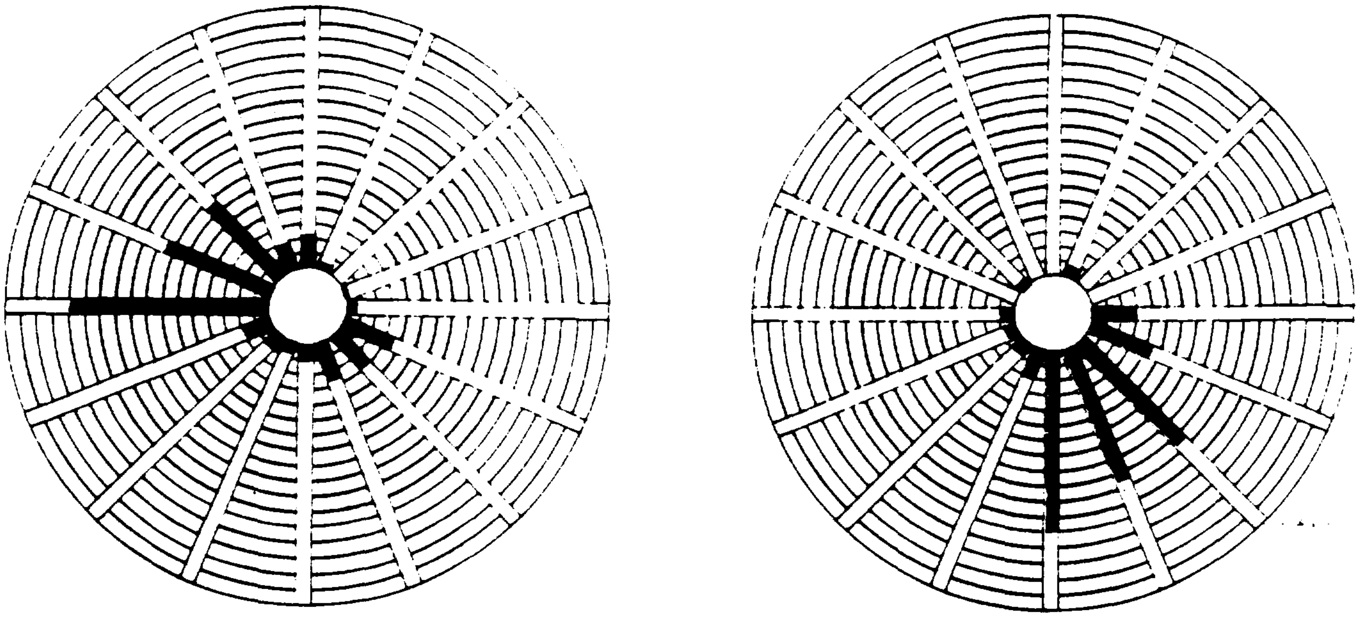
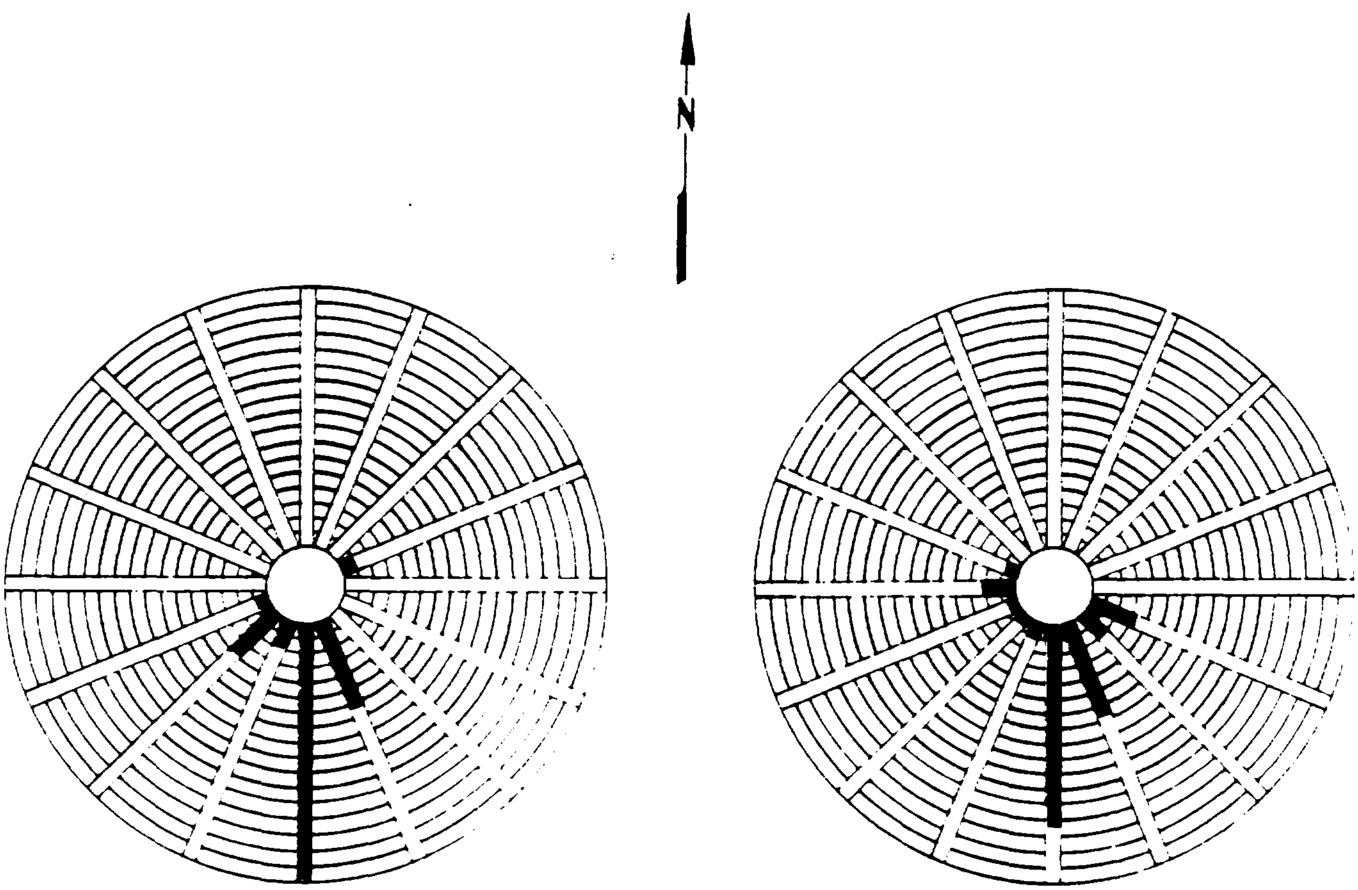


Figure VI - 5: Wind Frequency Distribution on High Lead Days in Granite City During 1982



15th and Madison | Each line equals 2% | Roosevelt and Rock Road (does not include November)



20th and Adams | Each line equals 3% | 1733 Cleveland

Figure VI - 6: Overlap of Lead Pollution Roses for 1982

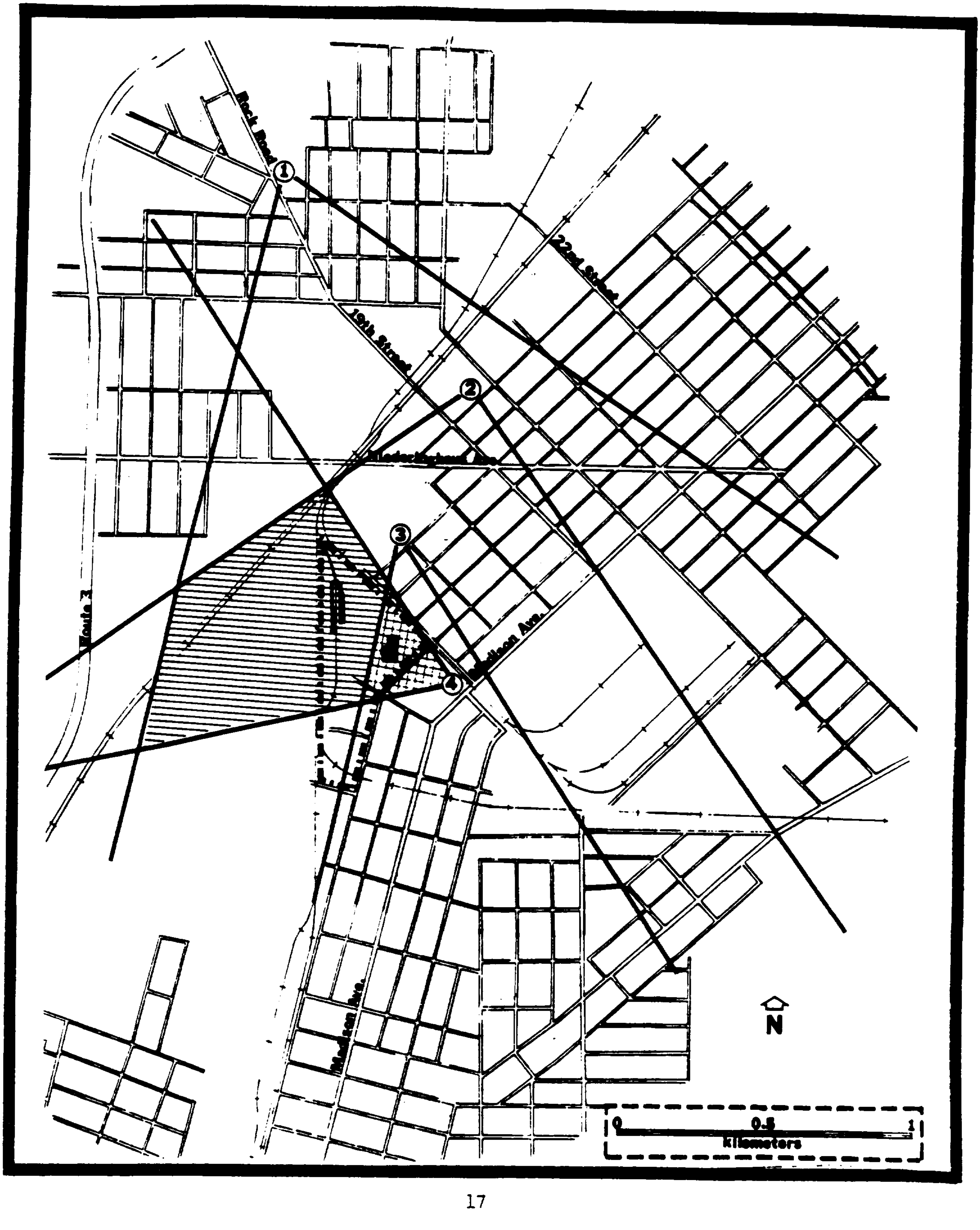
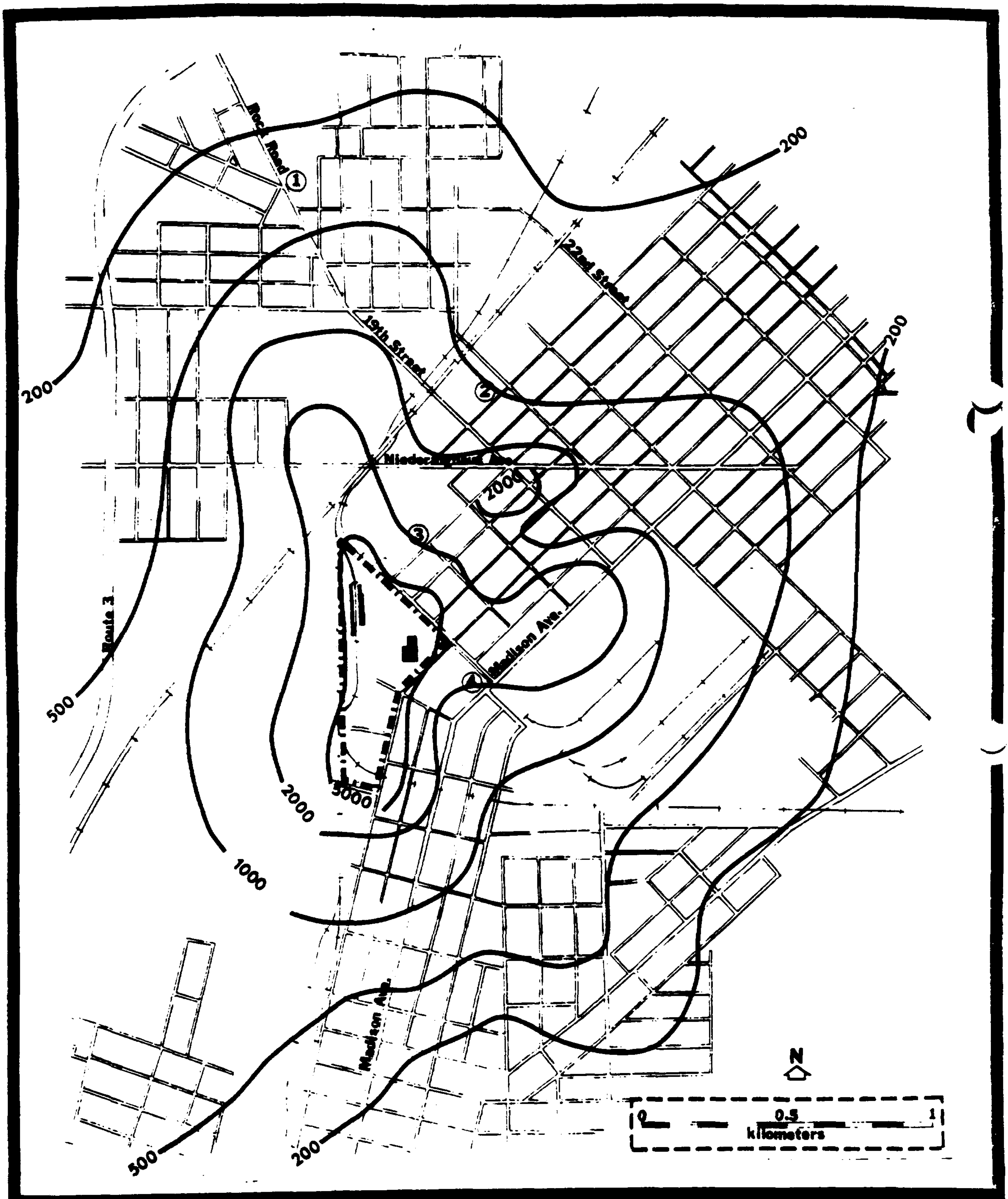


Figure VI - 7: Lead Concentrations in Surface Soil (ppm)



D) Major Emission Sources

Emission sources at the smelter, the recycling operation and adjoining grounds can be placed in two general catagories: process, and fugitive sources.

1) Process Sources

The Taracorp blast furnace (and associated activities) is the largest process source in the area. Materials handling activities prior to loading of the furnace skip hoist are discussed under the fugitive source section. Beginning with the loading of the skip hoist, however, significant process fugitive emissions are likely. The loading of the skip hoist and the subsequent charging of material into the furnace is poorly controlled. The charging of materials such as lead flue dust can cause significant emissions. Tapping operations are also poorly controlled and may contribute substantial emissions. Although under normal operations an attempt is made to control exhaust gases from the blast furnace, the overall system configuration does not represent good engineering practice. Under malfunction or charge bridging conditions, excess emissions are likely.

The rotary furnace is a second major potential emission source when in use. Poor hooding capture efficiency may allow significant emissions to escape into the "Mixed Metals A" building, where they are subsequently emitted to the ambient air.

Numerous kettles and operations throughout the facility are uncontrolled. Although not major sources taken individually, such sources may contribute substantial emissions when taken together.

Other process sources at both Taracorp and St. Louis Lead Recyclers should not contribute significant emissions under normal operations, but may be major sources under malfunction situations.

2) Fugitive Sources

Fugitive emissions are a significant cause of air quality problems in the area.

Handling of lead bearing material, particularly flue dust and battery plates, may result in significant emissions. This is especially true for the materials handling activities associated with blast furnace operations.

As discussed in Section IX, Land Pollution Problems, the soil on-site is heavily contaminated with lead. Resuspended dust from vehicular traffic as well as wind blown dust from the ground and waste storage piles can produce large quantities of lead particulate.

Additionally, the working of the waste pile can generate significant fugitive emissions.

E) Receptor Modeling

A detailed dispersion modeling analysis of lead air quality in the Granite City-Madison-Venice area was completed by the IEPA in February 1981. This analysis, which is discussed in detail in Volume 9 of the Illinois State Implementation Plan (SIP), indicated that both plant-related and non plant-related (i.e., fugitive emission) sources contribute to the elevated lead air quality levels in the area. The study also explained that a portion of the elevated lead levels in the area could not be accounted for with the emissions inventory that was used.

To provide for a more definitive analysis, a refined lead emissions inventory has been developed based on a more complete understanding of sources in the area. The factors contributing to this better understanding are as follows:

1) improved guidance concerning source emission factors;
2) more detailed knowledge of plant operations;
3) results of soil-lead sample analyses; and
4) updated estimates of lead emissions associated with motor vehicle activity.

To take advantage of the latest analytical tools available for verifying the significant sources of lead in the area, the IEPA has begun using receptor modeling techniques.

Until recently, dispersion models have been relied upon to apportion source impacts based upon assumptions regarding emission factors, plume behavior and meteorology. These models are sometimes not sufficient to accurately assess short-term source impacts or account for the sources contributing the total mass at a particular monitor. This is largely the result of the difficulties involved in developing realistic 24-hour inventories. In many instances receptor models, which incorporate data collected at a receptor (monitor) in order to deduce source impacts, have proven to be better for the short-term investigation of particulate sources. Receptor models can best be used in a complimentary fashion to improve accuracy and add confidence to the dispersion modeling analysis.

In this study the Chemical Element Balance (CEB) model, which matches source chemical "fingerprints" to those measured at the monitor in order to back-calculate the contributions from specific sources and source classes, is being used. This method requires that the suspected sources of lead and the monitor filters be analyzed for several chemical species by percent weight. X-ray fluorescence is recommended as a cost-effective and efficient method of analysing the samples for the spectrum of elements needed to explain the bulk of the particulate mass collected at the monitors. In the CEB model certain "fitting" elements are chosen based on experience and trial and error. These are used to construct a set of predictive equations, which are weighted to account for the uncertainties in the measurements of the various chemical species. This set of equations is then iteratively solved using statistical techniques. When an adequate fit is achieved, the mass contributed to the monitor by each source is computed for that day. By analyzing multiple days and considering meteorological data, an adjustment can often be made to the various emission factors used in dispersion modeling. Dispersion modeling analysis is still the best approach to determining the spatial extent of pollutant concentrations.

The CEB model has been programmed and is working. Some minor program refinements and test runs are necessary before the actual data is analyzed. Source samples have been collected and monitor filters have been selected for the chemical analysis. Arrangements have been made through USEPA Region V to have the chemical analysis performed. The company which is performing the analysis has extensive experience in both x-ray fluorescence and receptor modeling. Analysis of the filters by the contractor will be completed by the end of May 1983.

F) <u>Air Quality Modeling</u>

To further refine the dispersion modeling done previously, more extensive analyses will be conducted using the Industrial Source Complex Model (ISC). This model is listed as the USEPA Guideline Model designed to evaluate air quality in the vicinity of industrial complexes.

Point source, area source, and mobile source emissions are input to the model consistent with IEPA understanding of their operating rates during 1981. As it becomes available, the information resulting from the receptor modeling analysis will be used to supplement and refine the inventory which has been prepared. The results predicted by the model for each calendar quarter will be compared with lead air monitoring data collected during the same period. Based on these results, a correction factor will be developed for subsequent use with the model in this area.

Surface meteorological data collected by the National Weather Service (NWS) at St. Louis Lambert Field is being used. Upper air data from the nearest NWS site (Salem, Illinois) is being used as a basis for mixing height information.

The portion of the Granite City-Madison-Venice area being evaluated consists of a circular area, one mile in diameter, centered on the Taracorp facility. The density of theoretical receptors is greatest near the center of the area.

The revised air quality modeling analyses will be completed in the summer of 1983. These analyses will assist in determining the need for and adequacy of additional control measures beyond those already being considered.

VII) GROUNDWATER POLLUTION ASSESSMENT

The Granite City-Madison-Venice area is located in the American Bottoms where the soil consists principally of sand to a depth of about 120 feet. Although lead is generally insoluble and does not readily migrate through soil, the sandy conditions of the area, as well as the potential acidic conditions caused by the presence of battery acid, make the likelihood of groundwater contamination much more significant.

The groundwater in the area is not used for public consumption. Several industries do use groundwater for process purposes, including 3.6 million gallons per day by Granite City Steel. The public water supply in the area is drawn from the Mississippi River and complies with the lead drinking water quality standards.

Four monitoring wells were installed by Taracorp in November 1982. IEPA's opportunity to provide input as to the location of these wells was minimal. The locations of the wells is indicated in Figure VII-1. The initial sample results for lead (as evaluated by IEPA) are presented below.

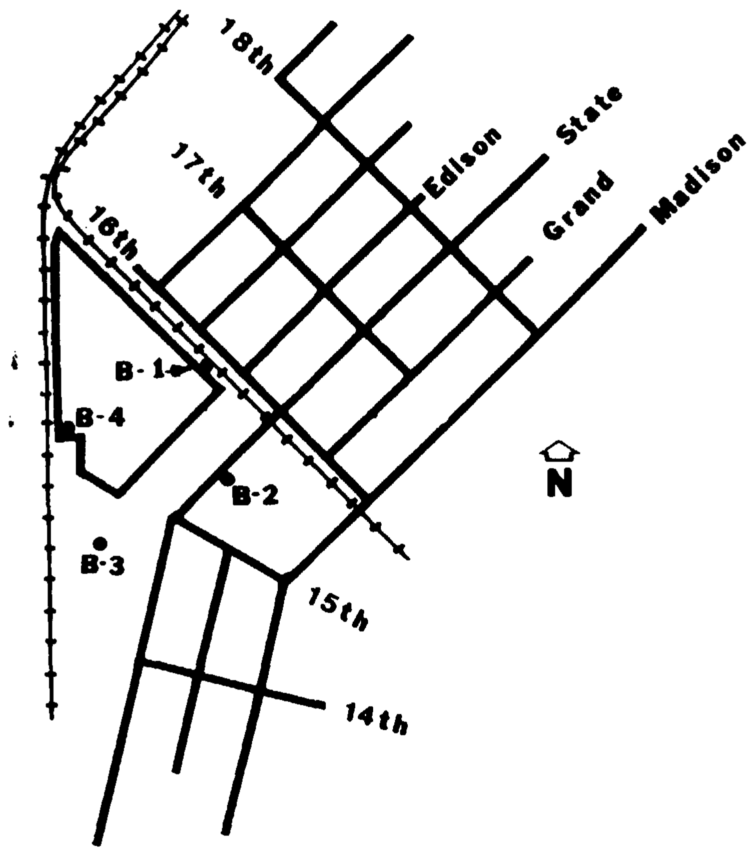
Table VII-1. Lead Concentrations in Groundwater (micrograms per liter - ug/l)

Well G101	Well G102	Well G103	Well G104
< 5	< 5	< 5	60

Since the drinking water standard for lead is 50 ug/l, the lead concentrations do not appear significantly elevated. However, the variation among wells with regard to lead concentration cannot be readily explained. In addition, these results are only preliminary, and no final conclusions should be drawn until additional samples are taken and at least one additional well is in place.

During the boring of Well G101, soil samples were obtained at every five-foot interval. These samples were then split with Taracorp and subsequently analyzed. The results of the Agency's analysis for lead is as follows:

Figure VII - 1 : Ground Water Sampling Well Locations



Boring and Monitor Well Locations

B-1 = G101
B-2 = G102
B-3 = G103
B-4 = G104

Table VII-2. Lead Concentrations at Various Depths in Soil Taken from Boring of Well G101 (parts per million)

	Sample Depth	Lead Present in ppm
(data in feet below ground surface)	4 - 5.5 feet	43
	9 - 10.5 feet	51
	14 - 15.5 feet	2700
	19 - 20.5 feet	43
	24 - 25.5 feet	14
	29 - 30.5 feet	13

From the preliminary data it appears that the lead may be migrating down through the soil 14-15 feet below ground surface and precipitating out. Further sampling will have to be done to determine the cause of the high lead level at this depth.

Listed below are the water elevations from the monitor wells. Notice the rise in elevation between the November and January sampling. The water elevations show a general movement of the groundwater to the southwest.

	November 16, 1982	January 26, 1983	February 28, 1983
G101	399.3	402.8	402.9
G102	399.2	-----	401.6
G103	398.2	402.1	401.9
G104	397.7	400.5	400.6

The water table during these three sampling periods was slightly below the level of the soil sample that had the 2700 ppm of lead. It appears from the water chemical analysis that at this time the lead is being tied up in the soil. This does not mean that the lead cannot become mobile again.

G101 was intended to be the upgradient well but it appears from the groundwater analysis data, for pollutants other than lead, to be affected by the waste pile. Therefore, another upgradient well north of the site is needed. This should be drilled and constructed in the same manner as the previous set of wells. Another boring south of the site taking frequent soil samples and having them analyzed for lead would help to confirm the present data from the initial boring and the speculation on the movement of the lead down through the soils.

VIII) SURFACE WATER POLLUTION ASSESSMENT

A) Taracorp

The IEPA's Division of Water Pollution Control has never issued Taracorp any permit. However, permits are required for the battery acid neutralization system and the oil skimmer in the Pipe Department. A permit application for the neutralization system was received on January 17, 1983, but was found to be incomplete. The application was denied on February 25, 1983.

In addition, Taracorp has not characterized the lead concentration of runoff from their property. This runoff enters the Granite City combined sewer system and may contribute to water pollution through overflows or through problems caused in the Granite City treatment plant. Although effluent from the treatment plant meets State requirements, the lead content of the sludge is among the highest in the State. This sludge is currently being disposed of in an approved landfill.

B) St. Louis Lead Recyclers

St. Louis Lead Recyclers holds a State permit for its pretreatment facility. The discharge point appears to be in compliance with all applicable rules, and no additional discharge points are believed to exist.

However, the grounds of St. Louis Lead Recyclers (which are leased from Bank Trust 454) are extensively contaminated with lead. In addition, St. Louis Lead Recyclers has over 6,000 tons of processed hard rubber, contaminated with lead, piled outside.

IX) LAND POLLUTION ASSESSMENT

A) On-site

Taracorp maintains a waste pile of lead bearing scrap covering approximately three acres and containing about 200,000 tons of material. The degree to which this pile extends below ground is unknown. The analyses of samples taken from the pile indicate that these materials are high in lead content. Slag and matte generated from the blast furnace operations are still being deposited on the pile. Because of the high lead content of the material in the pile, further evaluation of potential health hazards is planned.

In addition, operations of St. Louis Lead Recyclers involve transferring large quantities of wastes from one location to another. In sorting the material to be recycled, slag, matte and trash are separated out and piled in the open.

The hard rubber generated from the recycling process was spread-out over the Bank Trust 454 property as ground cover during the summer of 1982. Excess rubber was placed in an outdoor storage pile. Because of the high lead content of the hard rubber, St. Louis Lead Recyclers took up the spreadout hard rubber and placed it on the storage pile to reduce leaching and reintrainment. Process changes have also been made to reduce residual lead.

Total soil-lead analyses were performed at several locations on the site grounds. Samples were taken near the rear gate area of Taracorp in August of 1982. These samples indicated that the soil contained 300,000 ppm (30 percent) lead. Subsequent to this finding, St. Louis Lead Recyclers removed the top few inches of soil (when they removed the hard rubber) and Taracorp applied gravel to the immediate area. Samples taken after this indicate that soil in the rear gate area still contains about 140,000 ppm lead. Samples taken on other portions of the Bank Trust 454 property indicate high lead levels in the soil. The results of this sampling are presented in Table IX-1, and the locations of the sampling points are shown in Figure IX-1 .

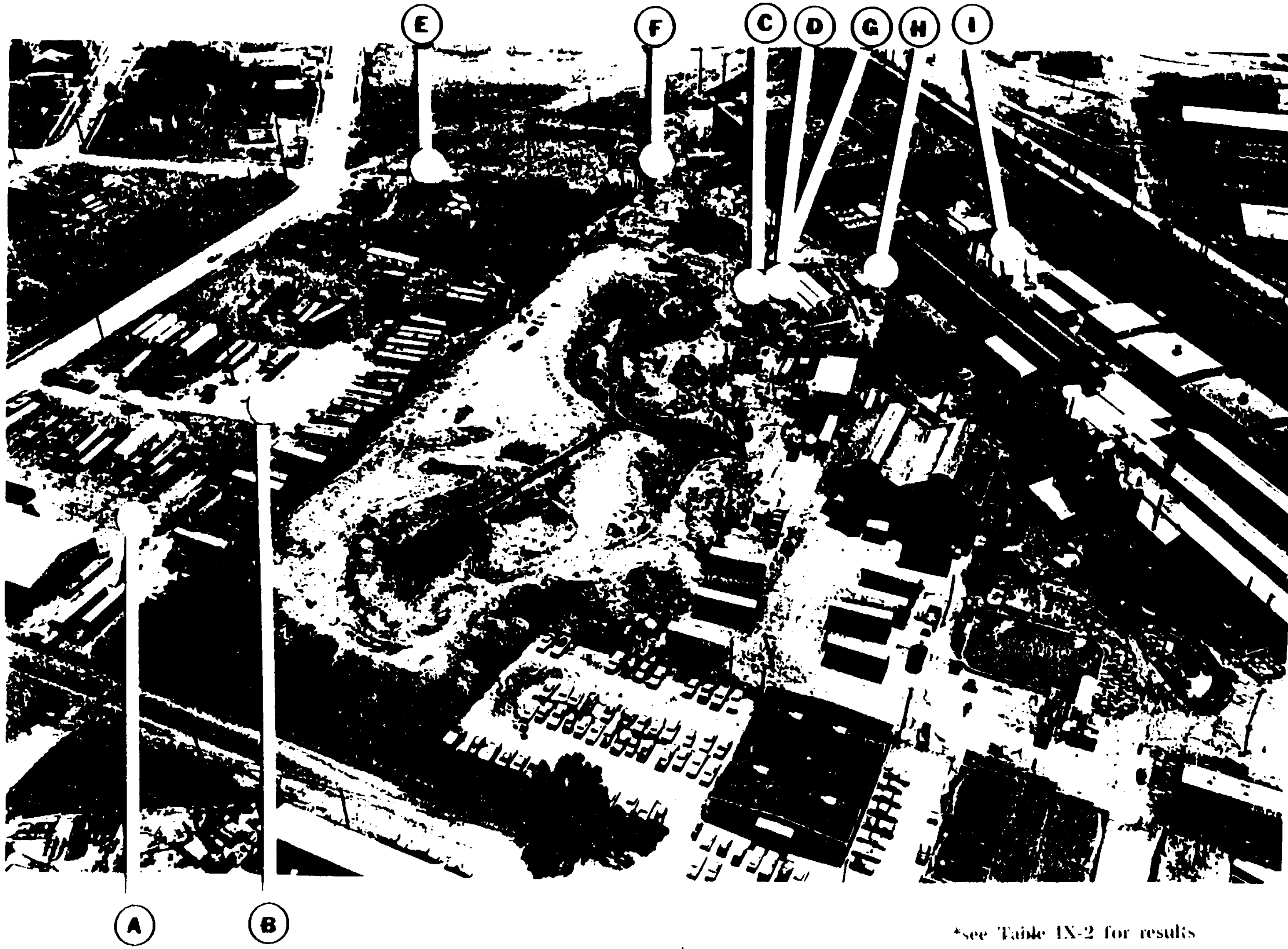
Table IX-1. Soil-Lead Concentrations for On-Site Samples

Sample	Concentration (ppm Lead)	Date of Sample
A	12,000	(8/19/82)
B	75,000	(8/19/82)
C	300,000	(8/19/82)
D	300,000	(8/19/82)
E	5,100	(1/27/83)
F	86,000	(1/27/83)
G	140,000	(1/27/83)
H	48,000	(1/27/83)
I	67,000	(1/27/83)

B. Off-site

Soil samples were taken from neighborhoods in the vicinity of the smelter. Four types of samples were taken: "A", "B", "C", and "Garden". "A" and "B" samples were taken with a standard soil borer/auger, one inch in diameter. The sampler was rotated as it was pushed into the soil to prevent compression of the sample. Only the uppermost inch was removed from the core and placed in a container. No attempt was made to remove vegetation, but this was not used in the profile's dimension. This procedure was repeated three times to obtain a composite sample. Each sample was removed at a distance of no less than 10 feet from any other sample. Care was taken to select undisturbed soil and to avoid removing a sample within 10 feet of painted structures, former structures, waste piles, roadways, or painted playground equipment.

Figure IX - 1: Location of On-site Surface Soil Samples*



*see Table IX-2 for results

Each sample type is discussed below:

"Soil A" - These samples were taken primarily to determine long term deposition patterns. The samples were taken from vegetated areas where the soil was unlikely to have been recently disturbed.

"Soil B" - These samples, which were intended to indicate levels to which children would most likely be exposed, were taken from open dirt areas in yards, playgrounds, etc. Samples were split between IEPA, IDPH and USEPA.

"Soil C" - These samples (2) were taken to determine the depth to which high lead levels may extend in the soil. The above protocol was used except that one nine-inch core was taken instead of three one-inch cores. The nine-inch core was divided into three, 3-inch sections for analysis.

"Garden" - As a part of the garden vegetable sampling program, soil samples were taken from each garden sampled. The samples were taken from the top three inches of soil with a spatula.

The results of "Soil A", "Soil B", "Garden" and the top three-inch section of "Soil C" samples are presented in Figure IX-2. It can be seen that the soil concentrations are generally highest in the immediate vicinity of the smelter and decrease with increasing distance. Using "Soil A" samples as the most reliable upper estimates of soil concentration (because they represent undisturbed soils) and recognizing that the other samples may underestimate typical surface soil concentrations, some rough lead concentration isopleths can be drawn. This has been done in Figure VI-7. The implication of these soil concentrations is discussed in the Hazard Assessment Section.

The "Soil B" values presented in Figure IX-2 are averages of values reported by IEPA, IDPH and USEPA. The agency-specific values are generally in good agreement, and provide confidence in the reliability of the laboratory results. The values are presented in Table IX-2.

Figure IX - 2: Surface Soil Sample Results (ppm Lead)

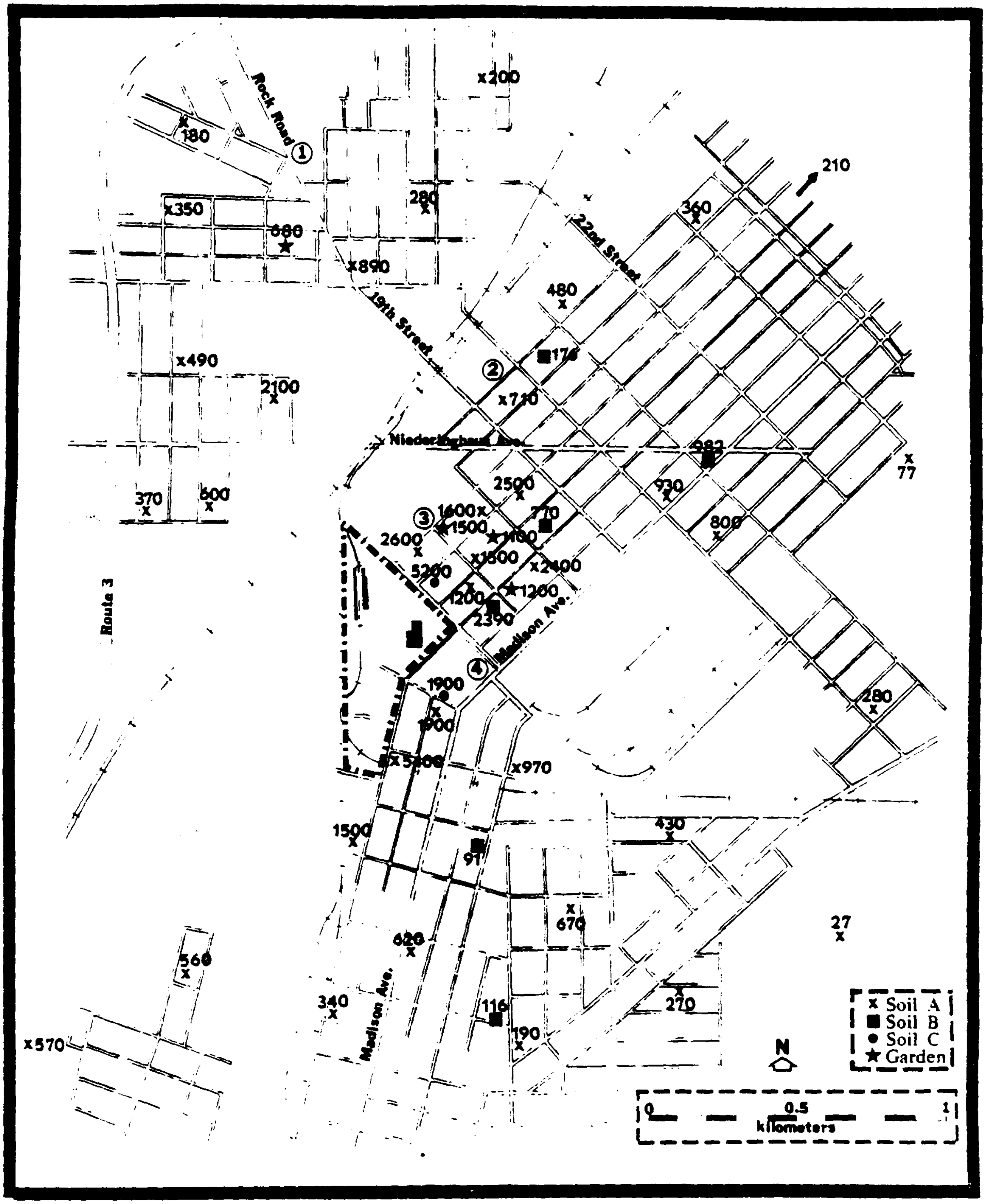


Table IX-2. Soil-Lead Concentrations for "Soil B" Samples (ppm)

Sample Number	Avg.	IEPA	IDPH	USEPA
SB101	2390	2600	2860	1700
SB102	770	800	759	750
SB103	982	950	995	1000
SB104	176	200	159	170
SB105	51	59	44	49
SB201	116	120	108	120
SB202	91	120	76	76

"Soil C" sample results, presented in Table IX-3, demonstrate that lead contamination extends at least as far as nine inches below the surface.

Table IX-3. Soil-Lead Concentrations for "Soil C" Samples (ppm)

Sample Number	0-3"	3-6"	6-9"
SC101	5200	1300	290
SC201	1900	810	980

X) HEALTH HAZARD ASSESSMENT

Through the use of environmental quality data, a rough estimate of human exposure to lead can be made. Comparing the exposure estimates to what is known about the toxicity of this substance, an estimate of the likely health effects can also be made.

In addition, attempts have been made to directly measure the extent of lead exposure in the population. This has been done by the Illinois Department of Public Health (IDPH) through a survey of blood-lead levels in the community. These measurements can aid in the overall assessment of the potential health hazard.

The hazard assessment is made by combining these factors. Exposure estimates can be compared to what is known about acceptable exposure levels; estimated blood-lead levels can be compared to acceptable blood-lead levels; and measured blood-lead and FEP levels can serve as direct checks on the estimates.

A) Toxicity of Lead

1) Routes of Exposure and Absorption

Inhalation

Lead can be absorbed into the bloodstream by inhaling airborne particulates containing lead. The rate of absorption depends on the particle size, the chemical species of lead, as well as factors specific to the individual. Although the relationship between ambient air lead concentrations and blood-lead concentrations varies considerably among individuals, nearly all studies have demonstrated ratios of 1:0.5 to 1:4.0 (ug/m^3 Pb to ug/dl Blood-Pb). Most studies report ratios of 1:1 to 1:2 (Ref. 1, pp 12-25, 12-29). Although USEPA has stated that no one ratio can accurately describe the air lead to blood lead ratio in all cases, one was selected by the USEPA as being representative of study results when the NAAQS for lead was proposed. The ratio was 1:2, indicating that a change in the ambient air lead concentration of 1 ug/m^3 results in a corresponding change of 2 ug lead per deciliter (dl) of blood (Ref. 3, p 41211).

Data cited in USEPA's Preliminary Draft Air Quality Criteria Document generally supports a linear relationship in the range of 1:1 to 1:4 for relatively low ambient concentrations (3.2 ug/m^3 or less) (Ref. 4, p. 13-27 to 13-29).

Oral Ingestion

The gastrointestinal tract is not as efficient in absorbing lead as the lungs. Absorption rates vary with a number of factors, including age, form of intake (food, soil, water, etc.), and nutritional factors. The chemical species of the lead may also be important. In general, adults will absorb 10-15 percent of ingested lead, but children may absorb up to 50 percent (Ref 1, p 10-2; Ref 4, p 13-5; Ref 6, p C-16).

Scientific studies have not developed a precise relationship between ingested lead and blood-lead levels. A general relationship of a 3-6 percent increase in blood-lead for a doubling of soil-lead concentrations has been noted in some studies (Ref 1, p 12-32). However, it is uncertain how much of this is due to inhalation and how much is due to ingestion. The relationship between blood-lead and soil-lead is discussed further in subsection X(C).

Food and water intake and its relationship to blood-lead is also unclear. Although a general relationship of 6 ug/dl blood-lead for every 100 ug of daily dietary lead intake is suggested by various studies, there are many variables determining this rate, and the rate for children is expected to be higher (Ref 1, p 10-4, p 12-32).

Maximum acceptable daily dietary intake for children has been estimated to be 300 ug/day, with only 150 ug/day allowed for children under age three, and only 100 ug/day for infants under six months (Ref 7, p 5).

2) Distribution and Elimination

Once lead has entered the blood stream it has a high affinity for bone deposition. Roughly 95 percent of the lead found in adults is contained in the bones (Ref 1, pg 10-5). However, only about 72 percent of the lead in children is in the bones. More is found in the soft tissues, increasing its availability for recirculation (Ref 5, p C--20).

Blood-lead concentrations generally level off after a few months of constant exposure. This does not represent a true equilibrium level, however, as elimination of lead following termination of exposure generally takes much longer when the exposure occurred over several years as opposed to several months (Ref 5, p C-20; Ref 6, p 417).

In adults, lead is eliminated primarily through the urine, with fecal elimination and loss of epithelical tissue being of secondary importance. In children, however, fecal elimination appears to predominate (Ref 6, p 418).

3) Biological Effects

Lead intoxication has been associated with severe neurological disorders such as profound retardation, tremors, and loss of memory. Coma and death, though rare, have occurred in some extreme cases. However, these problems occur at much higher dosages than would normally be expected from environmental pollution (Ref 6, p 418). Environmental exposures can cause more subtle toxic effects such as blood system dysfunction, psyco-neurologic dysfunction, kidney dysfunction, and reproductive impairment.

Blood System Dysfunction

Anemia is presently considered to be the toxic effect occurring at the lowest excess blood-lead level. The anemia apparently can result from two separte effects of lead on the blood system (Ref 1, p 11-7 to 11-14). One effect is an increase in the fragility of the red blood cell membrane. The result is to decrease the average lifetime of red blood cells in the circulatory system.

The second effect is a reduction in the rate of synthesis of "heme", which is a molecule used to make the hemoglobin in red blood cells. The result is to decrease red blood cell production. One of the mechanisms by which this is believed to occur is the inhibition of a particular enzyme used in heme synthesis. Although inhibition of this enzyme occurs at blood-lead levels as low as 10 ug/dl, sufficient inhibition to significantly interfere with heme synthesis and result in amenia apparently does not occur until blood-lead levels of approximately 40 ug/dl. Thus, 40 ug/dl was considered a "threshold" level in the development of the NAAQS by the USEPA. However, USEPA designated 30 ug/dl as the maximum allowable level for children to provide an adequate margin of safety (Ref 2, p 46253).

Another result of enzyme inhibition in the heme synthesis process is the buildup of an organic chemical, protoporphyrin, in the erythrocytes, or red blood cells. Although not perfectly correlated with blood-lead levels, a test of erythrocyte protoporphyrin, or "EP", levels is often used as a screening technique for lead poisoning and is a better indicator of long-term (greater than 90-day) exposure.

<u>Psyco-neurologic Dysfunction</u>

Lead poisoning can cause profound psyco-neurological dysfunctions. Children appear to be the most susceptible portion of the population. Research has indicated that blood-lead levels as low as 50-60 ug/dl can cause significant psyco-neurological disorders (Ref 1, pp 11-18 to 11-26).

Since the publication of USEPA's 1977 Air Quality Criteria Document for Lead, many studies have been released on psyco-neurological effects at blood-lead levels of 30-40 mg/dl and below. The preliminary draft of the revised criteria document discusses these studies (Ref 4, pp 12-38 to 12-149). While some of the studies indicate significant impairment of performance skills due to lead exposure, the results cannot be considered conclusive because of methodological problems complicating their interpretation. The studies are receiving significant attention by USEPA in workshops being held on revisions to the criteria document.

Kidney Dysfunction

A progressive, degenerative disease of the kidneys called chronic lead nephropathy has been reported in industrial workers exposed to lead, older adults having had lead poisoning as children, and long-term drinkers of illicit lead-contaminated whiskey (Ref 1, p 11-44). Numerous methodological problems in measuring the relationship between lead exposure and kidney dysfunction exist. However, lead-related kidney disease and associated problems such as gout and hypertension continue to be a serious concern and the subject of toxicological study.

Reproductive Impairment

Lead readily crosses the placental barrier and may exert toxic effects directly on the conceptus or indirectly, through nutritional effects on the mother (Ref 1, p 11-46). Because of the relationship between lead exposure and reproductive impairment, women have generally been excluded from occupational environments containing lead.

Lead exposure has been associated with increased rates of stillbirth, miscarriage, premature membrane rupture and premature delivery (Ref 1, p 11-46).

While some evidence exists for teratogenic or mutagenic effects of lead, a direct association has not yet been established (Ref 1, p 1-47). Of particular concern, however, is the possibility of subtle, long-term behavioral or intelligence effects.

B) Exposure Estimates

1) Air

As shown in Section VI(A), Air Quality Monitoring, ambient lead concentrations have frequently exceeded 2.0 ug/m^3. This value as well as the NAAQS (1.5 ug/m^3) and 1.0 ug/m^3 is used in evaluating a range of exposures in subsection XI(C) of this report.

2) Soil

In Section IX(B), Land Pollution Problems - Off-site, soil sample results indicating extensive lead contamination in area neighborhoods are discussed. One set of soil samples was taken from exposed dirt areas where children may play.

These samples were designated "Soil B" samples and were designed to estimate actual levels to which children may be exposed. It can be seen from the results in Figure IX-2 that "Soil B" levels are slightly lower but roughly consistent with other soil samples. To encompass the range of soil concentrations found in the area, values of 200, 1,000, and 5,000 ppm are used in this report for the health hazard analysis, although the highest "Soil B" (open dirt areas) value was 2,390 ppm.

In order to determine exposure, some estimate must be made concerning the amount of soil a child can ingest. In reviewing the literature for an assessment of contaminated soil in Minnesota, Dr. Mary Arneson concluded that a reasonable estimate of the range of intake rates for children would be 50 to 500 mg dust or soil per hour of play. Although the number of hours per day that a child plays in a dirt area varies considerably, it is not unreasonable to assume that up to 5 hours of exposure could occur each day for an extended period of time during the summer. Thus, 250 to 2,500 mg of soil could be consumed each day, recognizing that 2,500 mg/day is probably extreme. Dr. Arneson also noted that from 20 to 100 mg/day may be ingested by infants (Ref 7, p 7).

In a National Academy of Sciences study on lead, soil intake values of 100 mg/day for children without pica, and 1000 mg/day for children with pica are reported (Ref. 8, p. 58). Pica is a condition affecting many children in which there is an unusually strong need for placing objects in the mouth.

The table below provides daily lead intakes that would result from the range of soil intakes and soil concentrations discussed above.

Table X-1. Daily Lead Intake (ug)

Daily Soil Intake (mg)	Soil Lead Concentrations (ppm) 200	1000	5000
20	4	20	100
100	20	100	500
500	100	500	2500
1000	200	1000	5000
2500	500	2500	12,500

3) Food

The average daily intake of lead from food has been estimated at 100 ug/day for children 0-2 years old and 150 ug/day for children 2-3 years old (Ref 8, p 47). An estimate of 210 ug/day has been made for children 8.5 years old (Ref 5, p C-7). In this study, samples were taken of garden vegetables throughout the region and subsequently analyzed in a United States Food and Drug Administration laboratory. Table X-2 displays the results. The samples were taken in the Fall of 1982. The soil concentrations associated with each garden are listed, and are indicative of the area in which the garden is located; sites 4, 5 and 6 are from control areas on the northeast side of Granite City.

Table X-2. Lead Concentrations in Garden Samples (ppm - wet weight*)

Site #	Sample	Pb
1	Peppers	0.119
	Tomatoes	0.122
	Banana Peppers	0.134
	Cauliflower (frozen)	0.198
	Soil	1500
2	Eggplant	0.048
	Tomatoes	0.066
	Okra	0.128
	Carrots	0.392
	Soil	1100
3	Tomatoes	0.035
	Cabbage	0.633
	Peppers	0.053
	Cucumber	0.083
	Soil	1200
4	Okra	0.020
	Banana Peppers	0.010
	Tomatoes	0.005
	Peas	0.002
	Soil	53
5**	Pepper	0.007
	Tomatoes	0.007
6	Okra	0.014
	Banana Peppers	0.010
	Soil	97
7	Tomatoes	0.028
	Squash	0.124
	Okra	0.641
	Beets	0.087
	Beet Leaves	0.058
	Soil	680

* Soil values are based on dry weight
** Site #5 is located across the street from Site #6. Therefore a separate soil sample was not taken.

Although lead concentrations vary considerably depending on the type of vegetable, it can generally be concluded that vegetables in the contaminated region contain from 0.05-0.5 ppm lead and vegetables in control regions contain from 0.005 to 0.05 ppm lead on a wet weight basis.

Assuming that 10 to 100 g/day (based on a total diet of 1000 g/day) of garden vetables may be consumed for an extended period of time by children, daily lead intake estimates may be increased by 0.5-5 to 5-50 ug/day.

Except for the high end of these estimates, they do not represent a major portion of the daily dietary intakes discussed above. Gardens in the vicinity of the smelter were generally small and were not believed to produce a large quantity of vegetables. In addition, only a few samples (carrots, cabbage, and okra) demonstrated lead levels higher than 0.2 ppm. Considering both these factors, it would be extremely unlikely that a child would consume 100 g/day of a vegetable containing 0.5 ppm lead each day for 30 to 90 consecutive days. A more reasonable estimate would be that vegetables consumed over such a period of time would be closer to an average of 0.1 ppm lead. This would mean an intake of 1 to 10 ug/day from garden vegetables.

Soil cation exchange capacity and pH are the two largest factors determining lead uptake by plants. Assuring near neutral pH and normal cation exchange capacity will minimize lead uptake. However, significantly altering soil cation exchange capacity is often difficult. Phosphate and pH levels appropriate for optimal garden productivity will aid in reducing lead uptake.

4) <u>Water</u>

Drinking water in the community is taken from the Mississippi River. The lead concentration is less than the State drinking water standard of 0.05 ppm and most samples are below the laboratory detection limit of 0.005 ppm. Thus, present data indicates that exposure from drinking water is not abnormal.

5) <u>Other</u>

There are many other sources of lead exposure for children. One of the major sources can be consumption of lead-based paint chips in the home. Exposure through the work or hobbies of others in the family is also important. Many of these potential exposure sources were investigated through a questionnaire administered to residents in the area by IDPH in connection with their blood-lead survey. These other exposure sources were not found to be major based upon a preliminary analysis of the survey results.

C) Estimate of Blood-lead Levels

Much of the available toxicological data relates adverse effects to various concentrations of lead in the blood. Thus, estimating blood-lead concentrations resulting from environmental exposure is an important part of a health hazard assessment. Although much of the data is still preliminary, a rough estimate of potential health hazard can be made.

USEPA, in developing the National Ambient Air Quality Standard for lead, estimated a background blood-lead concentration from non-air sources of 12 ug/dl (Ref. 1, p 46254). Using this number, total blood-lead can be estimated by adding the contributions from airborne lead and other sources having concentrations higher than the background level.

1) Air

Based on a review of studies documenting the relationship between air-lead and blood-lead concentrations, USEPA concluded that the best estimate was 1:2; that is, every 1 ug/m^3 increase in air-lead concentrations results in an increase of 2 ug/dl in blood-lead. They note, however, that a range appears to exist, and that the ratio may be more severe for children and more severe at lower air-lead concentrations (Ref 2, p 46250; Ref 1, p 12-24 to 12-29). The 1:2 ratio is used for this analysis.

Table XI-3 provides estimates of the increase in blood-lead concentrations that would result from the range of air-lead concentrations under study assuming the 1:2 air/blood relationship.

Table X-3. Increases in Blood-Lead Due to Various Air-Lead Concentrations

Ambient Air-Lead Concentration (ug/m3)	Increase in Blood-Lead (ug/dl)
1.0	2.0
1.5	3.0
2.0	4.0
7.3	14.6

2) Soil

National background soil concentrations of lead have been documented as 10-30 ppm (Ref 5, p C-2; Ref 8, p 156). Although soil-lead concentrations associated with the development of the 12 ug/dl background blood-lead level are not known, it is reasonable to assume that the soil lead concentrations in the vicinity of the smelter (200 - 5000 ppm) almost entirely represent contamination above background.

In the Preliminary Draft of the revised Criteria Document, USEPA cites a study from which soil/blood relationships have been derived for children 1-3 and 6 years of age (Ref 4, p 11-94). They report an increase above background of 0.0076 x soil-lead (ppm) for children 1-3 years old, and 0.0046 x soil-lead (ppm) for children 6 years old. Based upon these relationships, Table X-4 provides blood-lead estimates for each age group, over various soil concentrations, assuming that the 0.0046 x soil ppm can be applied to all children over three years old.

Table X-4 Increases in Blood-lead Concentrations from Soil Ingestion (ug/dl)

Soil Conc. (ppm)	Children 0-3 yrs old	Children over 3 yrs old
100	0.76	0.46
200	1.52	0.92
500	3.80	2.30
1000	7.60	4.60
2000	15.20	9.20
5000	38.00	23.00

Several qualifications should noted at this point. First, the above formulas are presented in a draft document that has not yet been released for general review. Thus, they are subject to change and cannot be considered to reflect a final USEPA position. Second, the background blood-lead levels found in the above study, and other studies, have generally been higher than the 12 ug/dl used in this analysis. However, the Granite City-Madison-Venice area has not been associated with high blood-lead levels from consumption of paint chips or other sources based upon earlier blood-lead screening work. It must be recognized that there is considerable uncertainty in selecting the appropriate background level and soil-lead/blood-lead relationship.

Angle et. al. (1983) have also reported a linear relationship between blood-lead and other variables, including soil concentration (Ref. 9, p. 6). They report an increase of 0.00681 ug/dl for each ppm soil concentration for children 1-18 years old. This is roughly consistent with the values reported above by USEPA.

3) Diet

Because food and water exposure were found to be unlikely to pose a significant increase in lead intake, it will be assumed that no contribution to blood-lead beyond background will occur.

4) Other

Household exposures were not found to be significant and are therefore assumed not to affect blood-lead levels based upon preliminary findings of the blood-lead survey.

5) Overall Estimate

To estimate the overall blood-lead levels, the effects of both air and soil exposure must be combined. Since air quality modeling results are not yet complete, a precise relationship between air concentrations and soil concentrations cannot yet be delineated. Thus, it is assumed for this analysis that any air quality level can occur in conjunction with any soil quality level. However, the association of high air with high soil lead as well as low air with low soil lead is likely.

For the overall estimate, the soil/blood relationships presented in Table X-4 were used. These values were added to the blood-lead values from air exposure (Table X-3) and the background value of 12 ug/dl to derive the overall estimates in Table X-5. It should be noted that these are estimates of the population mean. Table X-6 presents similar results for children over 3 years of age.

As discussed in subsection (A) above, Toxicity of Lead, USEPA selected a level of 30 ug/dl in setting the National Ambient Air Quality Standard (NAAQS) to provide a sufficient margin of safety for children. Given the natural variation in blood-lead levels, and USEPA's goal of keeping all but 0.5 percent of the exposed children below the 30 ug/dl level, a population mean blood-lead level of 15 ug/dl was selected. (It should be noted, however, that approximately five percent of children exceed 30 ug/dl as a national average). This is based on evidence that blood-lead concentrations are lognormally distributed over a population with a standard geometric deviation (SGD) of 1.3. Higher and lower SGD's have been measured, but 1.3 was selected by USEPA.

Table X-5 Overall Mean Blood-lead Level Estimates for Children 0-3 yrs Old

Soil Concentration (ppm)	Air Quality (ug/m^3)		
	1.0	1.5	2.0
100	14.76	15.76	16.76
200	15.52	16.52	17.52
500	17.80	18.80	19.80
1000	21.60	22.60	23.60
2000	29.20	30.20	31.20
5000	52.00	53.00	54.00

Table X-6 Overall Mean Blood-lead Level Estimates for Children Over 3 yrs Old

Soil Concentration (ppm)	Air Quality (ug/m^3)		
	1.0	1.5	2.0
100	14.46	15.46	16.46
200	14.92	15.92	16.92
500	16.30	17.30	18.30
1000	18.60	19.60	20.60
2000	23.20	24.20	25.20
5000	37.00	38.00	39.00

As individual child blood-lead concentrations increase above the margin-of-safety level of 30 ug/dl, there is increasing likelihood of toxic effects. At an individual blood-lead level of 40 ug/dl, anemia has been well documented. Thus, toxic effects are likely above this value. As the population mean value increases from 15 ug/dl, an increasing percentage of the population is expected to exceed 30 and 40 ug/dl. To better illustrate the potential hazard, Tables X-7 through X-10 were constructed to show the percentage of the childhood population exceeding 30 and 40 ug/dl based on the mean levels presented in Tables X-5 and X-6. These values were calculated assuming an SGD of 1.3.

Table X-7 Percent of Children 0-3 Yrs Old with Blood-lead Levels Above 30 ug/dl

Soil Concentration (ppm)	Air Quality (ug/m^3) 1.0	1.5	2.0
100	0.5	0.7	1.3
200	0.6	1.2	2.0
500	2.3	3.8	5.7
1000	10.6	14.0	18.1
2000	46.02	51.20	55.96
5000	98.20	98.50	98.75

Table X-8 Percent of Children Over 3 Yrs Old with Blood-lead Levels over 30 ug/dl

Soil Concentration (ppm)	Air Quality (ug/m^3) 1.0	1.5	2.0
100	0.3	0.6	1.1
200	0.4	0.8	1.5
500	1.0	1.8	3.0
1000	3.4	5.3	7.6
2000	16.4	20.6	25.5
5000	78.8	81.6	84.1

Table X-9 Percent of Children 0-3 Yrs Old with Blood-lead Levels Above 40 ug/dl

Soil Concentration (ppm)	Air Quality (ug/m^3)		
	1.0	1.5	2.0
100	0.0	0.0	0.0
200	0.0	0.0	0.1
500	0.1	0.2	0.4
1000	0.9	1.5	2.2
2000	11.5	14.2	11.1
5000	84.1	85.8	87.3

Table X-10 Percent of Children Over 3 Yrs Old with Blood-lead Levels over 40 Ug/dl

Soil Concentration (ppm)	Air Quality (ug/m^3)		
	1.0	1.5	2.0
100	0.0	0.0	0.0
200	0.0	0.0	0.0
500	0.0	0.0	0.1
1000	0.2	0.3	0.6
2000	1.9	2.7	3.9
5000	23.6	42.1	48.0

It can be seen from Tables X-5 and X-6 that, even for air quality levels under 2.0 mg/m^3 air quality, the percentage of children exceeding 30 mg/dl is far above USEPA's target of 0.5 percent, and significantly above the national average of 5 percent at higher soil levels. Note also that in areas of soil concentrations as high as 2000 to 5000 ppm, a substantial percentage of the children would exceed even the 40 ug/dl.

If the NAAQS of 1.5 ug/m3 were attained in the area, over 5 percent of the children would still exceed the margin-of-safety level of 30 ug/dl unless soils were reduced to less than 1000 ppm. Tables X-7 and X-8 illustrate that even if ambient air concentrations could be reduced to 1.0 ug/m3, 33 percent below the standard, soil concentrations of 1000 ppm or higher might still cause a significant percentage of the children to exceed the margin-of-safety level of 30 ug/dl. It should also be noted, based on the information in Tables X-9 and X-10, that in areas of high soil concentration, a significant percentage of the children could exceed 40 ug/m3. This clearly illustrates the difficulty in determining an acceptable concentration of lead in one medium (e.g., air) because of uncertainty with respect to exposure through other media (e.g., soil).

Although recent ambient lead air quality levels have been well below the 7.3 mg/m3 peak reported for the fourth quarter at 1981, exposures during that time could have placed more than one-third of the children over 30 ug/dl in areas where soil-lead levels exceed 200 ppm, and more than 10 percent of the children over 40 mg/dl in areas where soil-lead levels exceed 500 ppm.

D) IDPH Blood-lead Survey

To help assess the hazard posed by lead contamination in Granite City, the Illinois Department of Public Health (IDPH) conducted a survey of blood-lead concentrations. The survey consisted of three parts. The first part was a questionnaire concerning the household and its members. It was used to help identify sources of lead exposure. Secondly, each house where blood samples were taken was examined for lead paint and other sources of lead contamination. The third part of the survey was comprised of data on each individual, particularly the resulting blood-lead and FEP levels. FEP (free erythrocyte protoporphryn) is an enzyme whose release in the blood is directly proportional to lead exposure.

The survey was administered during the fourth quarter of 1982. Statistical analysis of the results took considerable time because of the necessity for lab work and data entry to the computer system. A complete statistical analysis of the numerous variables included in the questionnaire is expected within the next two months. However, preliminary results are available.

Several problems were anticipated with respect to obtaining complete survey information. One was obtaining the full cooperation of residents. Because of competing priorities in many family situations, the limited State resources that could be devoted to gaining cooperation, and the relatively short time frame within which the work had to be completed, it was anticipated that some public resistance might be encountered. Unfortunately, this was the case and surveys were completed for only 43 households (97 individuals, with 46 being six years old or less).

Another complication was the slowdown of activity at the smelter. Monitoring data for the period of the blood-lead survey (see Air Quality Monitoring Section) showed that outdoor air quality was much better than normal. Also, exposure to soil-lead was substantially reduced compared to the summer.

The preliminary results of the survey indicate that excessive blood-lead levels and FEP levels were not present in the sampled population. IDPH considers a blood-lead level of 30 ug/dl or more, in conjunction with an FEP level of 50 mg/dl or greater to be "undue lead absorption", that is, a dangerously high level of lead absorption. No such cases were found, even though one or two could have normally occurred in a sample of 46 urban children.

In addition, the low FEP values (indicative of longer-term lead exposures of several months to a year) indicate that significant lead exposure has not been occurring for the sampled individuals as a whole.

Numerous factors relating potential household exposures to blood-lead and FEP indicate that such exposures are not significantly above normal.

However, the small number of people willing to participate in the study limits the extent to which these conclusions can be extrapolated to the rest of the population in the area. Thus, no significant lead exposure problems were found in the survey of residents in the vicinity of the lead smelter, but the lack of citizen participation (which resulted in a relatively small sample size) and, to some extent, the timing of the sampling effort, means that some uncertainty remains with regard to a possible health hazard. The results, however, are consistent with previous blood-lead screening work done in 1976 and 1979.

E) Hazard Assessment

The public health hazard posed by lead contamination is based not only on the toxicity of lead, but also on the level of environmental contamination and the extent to which people, particularly children, are exposed to these levels.

The public is exposed to lead in the vicinity of the smelter primarily through three means: air, soil, and garden vegetables. Each will be discussed in turn, and then they will be combined with data from the blood-lead survey to produce an overall hazard assessment.

Air

Ambient air quality lead levels during 1982 were below 2.0 ug/m^3. Levels have been repeatedly monitored at levels exceeding the NAAQS (1.5 ug/m^3) have been monitored over the past four years, with a high of 7.3 ug/m^3 during the fourth quarter of 1981.

The potential for actual exposure of children to monitored ambient lead levels is greatest during the summer months when they spend a great deal of time outdoors. Thus, high ambient levels during the winter months should be less harmful than similar levels during the summer. Fortunately, the 1981 peak value of 7.3 ug/m^3 occurred in the Fall.

The NAAQS was based on the assumption that blood-lead due to air exposure would be added to a normal background blood-lead concentration of 12 ug/dl, and that exposures to more than 1.5 ug/m^3 would place a significant portion of the exposed children above the 30 ug/m^3 danger level. Thus, although ambient concentrations in 1982 were below 2.0 ug/m^3, levels above 1.5 ug/m^3 should be considered a potential health hazard. Significant exposures from other sources, such as soil, will aggrevate the effect of air exposure.

Soil

The soil-lead concentrations found in the study area are significantly above background levels, particularly in Granite City. Levels as high as 2000 ppm are common in the inner-city portions of many urban areas such as Cincinnati, Ohio (Ref. 10) and Morton Grove, Illinois (Ref. 11). In other studies of residential areas surrounding smelters, values of 100-4000 ppm have been found in E. Helena, Montana (Ref. 4); 20-1,100 ppm in the Netherlands (Ref. 12); 20-4,800 ppm in Omaha, Nebraska (Ref. 3); 560-11,450 ppm in El Paso, Texas (Ref. 19), and 50-24,600 ppm in Silver Valley, Idaho (Ref. 15).

When a case of undue lead absorption is found in a child by the Illinois Department of Public Health, soil levels around the residence are required to be reduced to 200 ppm as a part of an overall plan to reduce lead exposure for that child to a minimum.

Figure X-1 in the exposure section provided estimates of lead intake given various soil-lead concentrations, and various assumptions regarding daily soil ingestion. A daily soil intake of 0.1 g/day was used as a rough estimate for normal consumption by a child, and 1.0 g/day for a child with pica.

A maximum tolerated intake of lead for children 0.5-3 years old has been estimated at approximately 150 ug/day. This value is for daily intake from all sources. Most of this amount is ingested daily from normal diet, and very little from soil.

Based on Figure X-1, it can be seen that a substantial portion (100 ug/day) of the maximum tolerated daily intake of lead for normal children could be obtained from the soil in areas with concentrations over 1000 ppm. Although the USFDA maximum tolerated daily intake level is not related directly to a particular blood-lead level or toxic effect, exceeding the recommended level by 100 percent or more could generally be considered a hazard.

Estimates of blood-lead levels indicate that soil-lead concentrations over 1000 ppm may place a significant percentage of children at risk. In addition, consultation with others knowledgable in the field indicates a general concensus that soil-lead values of 1000-5000 ppm may be cause for concern (Ref. 16).

Garden Vegetables

Extended daily intakes of one to 10 ug/day from garden vegetables was estimated in the exposure section of this report. Compared to the 150 ug/day maximum tolerated daily intake limit, the contribution from eating garden vegetables grown in the area around the smelter appears to be minor.

However, this assessment is based on several assumptions. First, it is assumed that vegetables comprise no more than 10 percent of the diet by weight. Second, it is assumed that the amount of vegetables consumed over a period of 30 to 90 days is not primarily composed of root or leafy vegetables. Third, and most importantly, it is assumed that all vegetables are thoroughly washed. Eating unwashed leafy or root vegetables could greatly increase lead ingestion.

Overall Assessment

The preceding assessments, based upon results of studies in other areas, indicate that both air and soil concentrations found in the Granite City-Madison-Venice area could represent a health hazard. Garden vegetables grown in the vicinity of the smelter do not appear to pose a significant risk as long as they are thoroughly washed before eating.

Estimates made of blood-lead levels and the percentage of children exceeding 30 and 40 ug/dl (see Figures X-7 through X-10) indicate that soil concentrations over 1000 ppm, and especially over 2000 ppm, could pose a significant hazard, even if the NAAQS is attained in the area.

Preliminary findings from the IDPH blood-lead screening, however, indicate that unusually high blood-lead levels are not present. This may be partially explained by the fact that the samples were taken during November and December of 1982, when children were not spending many hours playing outdoors, and air quality levels were at or below the NAAQS. The fact that FEP blood values were not above acceptable levels indicates that exposure to lead during the preceding months to one year had not been unusually high.

The indication that high absorption of lead in the blood is not occuring is supported by a survey performed in September 1976 by the Illinois Association for Retarded Citizens, in which 4.5 percent, or about the national average, of the children in East Alton, Granite City, and Madison were found to have elevated blood-lead levels. Also supporting this conclusion are the results of a 1979 blood-lead screening of the area by the IDPH which indicate no unusual incidence of elevated blood-lead levels.

Thus, although significant environmental contamination exists in the vicinity of the smelter, and evaluation of the data collected must continue, the preliminary assessment is that a major risk to public health is unlikely to exist provided that ambient air quality levels do not exceed the NAAQS and that routine personal health and hygiene measures are followed.

References

1. Air Quality Criteria for Lead, USEPA, EPA-600/8-77-017, December 1977.

2. 43 FR 4625

3. 45 FR 41211

4. Air Quality Criteria for Lead, Preliminary Draft, Chapters 11, 12 13, USEPA, 12/82 - 1/83.

5. Ambient Water Quality Criteria for Lead, USEPA, EPA-440/5-80-057.

6. Toxicology: The Basic Science of Poisons, Second Edition, Casare H and Doull, MacMillan Publishing Company, 1980.

7. Lead Contamination of Lions Park in St. Lous Park: A Health Risk Assessment by Mary Arneson, M.D., 1981.

8. Lead in the Human Environment: Committee on Lead in the Human Environment, National Academy of Sciences.

9. "Omaha Childhood Blood Lead and Environmental Exposure: A Linear Model", Carol Angle, M.D., et. al., 1983 (Unpublished Preliminary Draft).

10. Conversation with Dr. Hammond, University of Cincinnati, Department of Toxicology, 3/22/83.

11. Morton Grove Lead Study: An Investigation of the Contribution of Automobile Exhaust to Blood Lead Levels in Suburban Children, S. J. Jansen, et. al., IIEQ Doc. No. 77/13, July, 1977.

12. "The Arnhem Lead Study", Brunekreff et. al., Environmental Research, V25, p 441, 1981.

13. "Environmental Lead and Children: The Omaha Study", C. R. Angle, and M.S. McIntire, Journal of Toxicology and Environmental Health, V5, N5, Sept., 1979.

14. "Epidemic Lead Absorption Near An Ore Smelter", P.J. Landrigan, et. al., New England Journal of Medicine, January 16, 1975.

15. "The Silver Valley Lead Study: The Relationship Between Childhood Blood Lead Levels and Environmental Exposure", Yunkel, et. al., Journal of the Air Pollution Control Association, V27, No. 8, August, 1977.

16. April 15, 1983, IEPA memo from Tom Bierma to Steve Tamplin detailing personal discussions with lead specialists.

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